

EXHIBIT 1



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Patrick

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- (54) **HEAT MANAGEMENT FOR A LIGHT FIXTURE WITH AN ADJUSTABLE OPTICAL DISTRIBUTION**

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This patent is subject to a terminal disclaimer.

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- (63) Continuation of application No. 12/183,490, filed on Jul. 31, 2008, now Pat. No. 7,874,700.

(60) Provisional application No. 60/994,371, filed on Sep. 19, 2007.

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F2IV 21/00 (2006.01)
F2IV 29/00 (2006.01)
F2IV 29/02 (2006.01)

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362/373

(58) **Field of Classification Search** 362/249.02,
362/218, 294, 373

See application file for complete search history.

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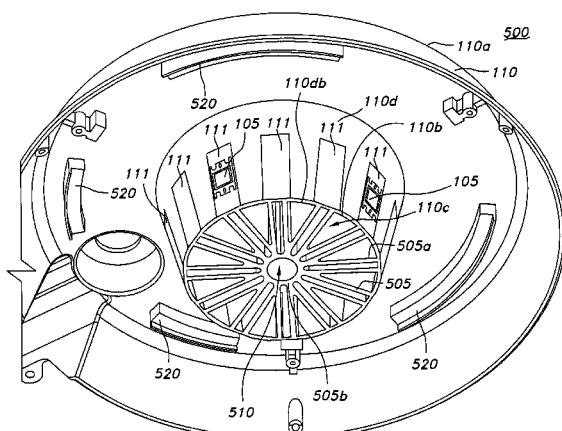
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(57) **ABSTRACT**

A light fixture includes a member having a substantially frusto-conical shape. A channel extends between a wide top end of the member and a narrower bottom end of the member. The member includes multiple surfaces ("facets") disposed around its outer surface. Each facet is configured to receive one or more light emitting diodes ("LEDs") in a linear or non-linear array. Each facet can be integral to the member or coupled to the member. The channel is configured to transfer heat generated by the LEDs through convection. Fins can be disposed within the channel, extending from the inner surface of the member to an inner channel. The fins are configured to transfer heat away from, and provide a greater surface area for convecting heat away from, the member. For example, one or both of the channels can transfer heat by a venturi effect.

20 Claims, 5 Drawing Sheets



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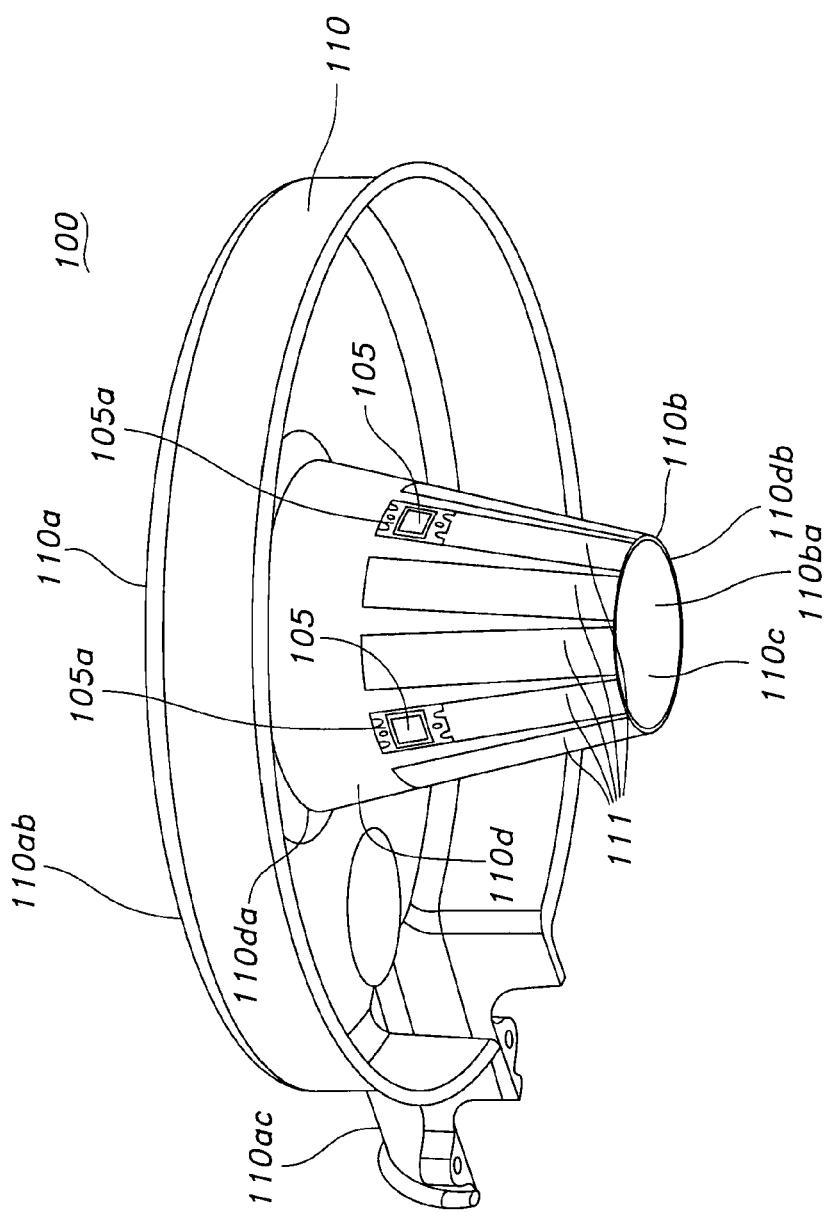


FIG. 1

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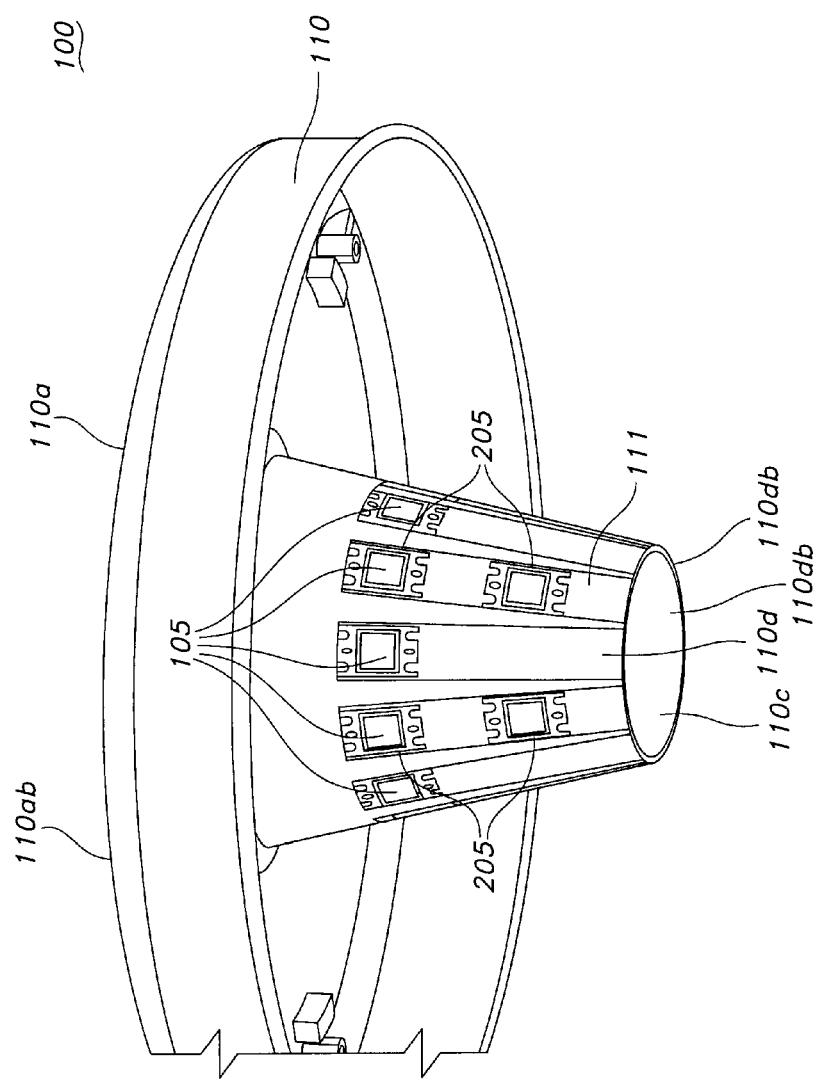


FIG. 2

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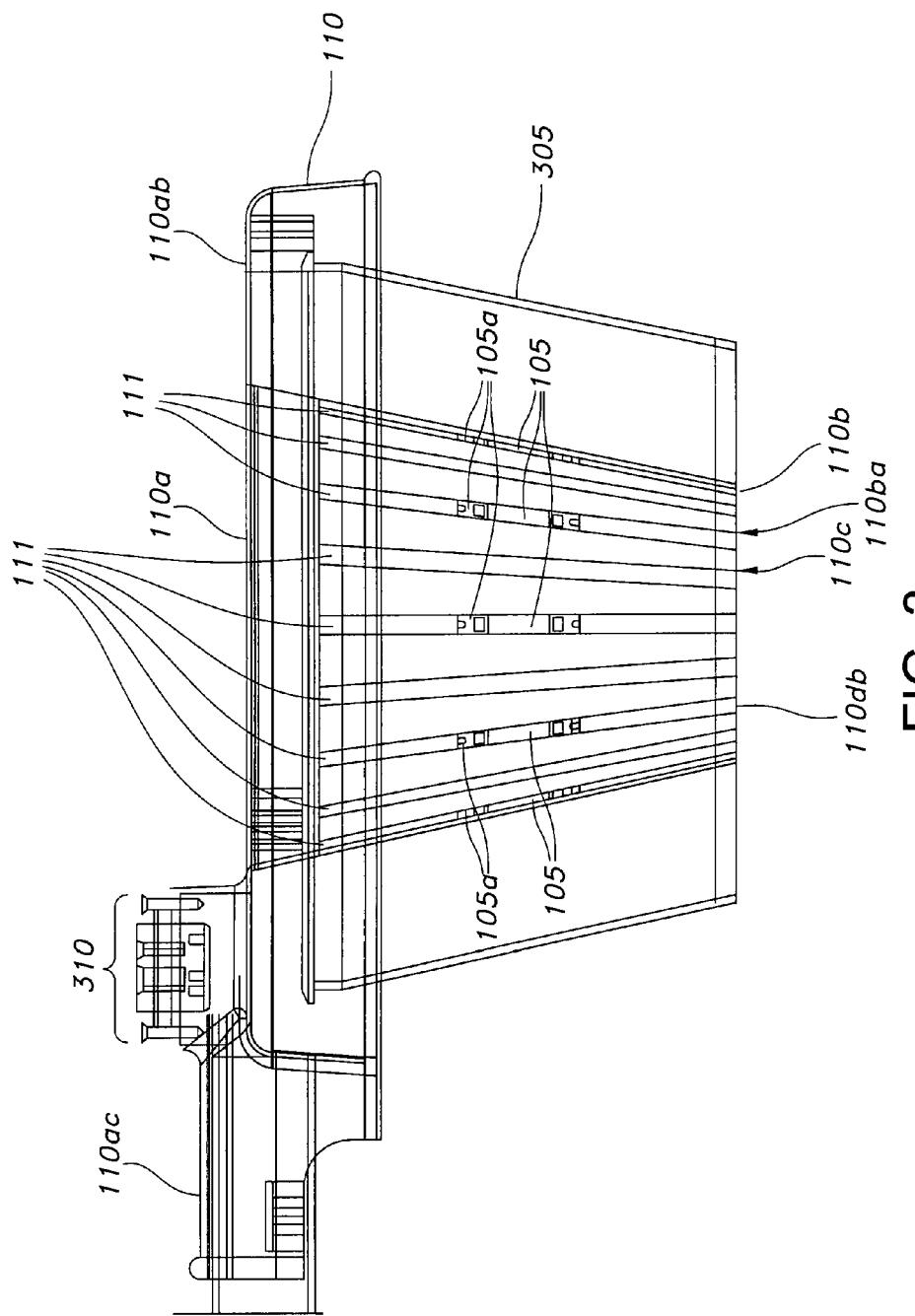


FIG. 3

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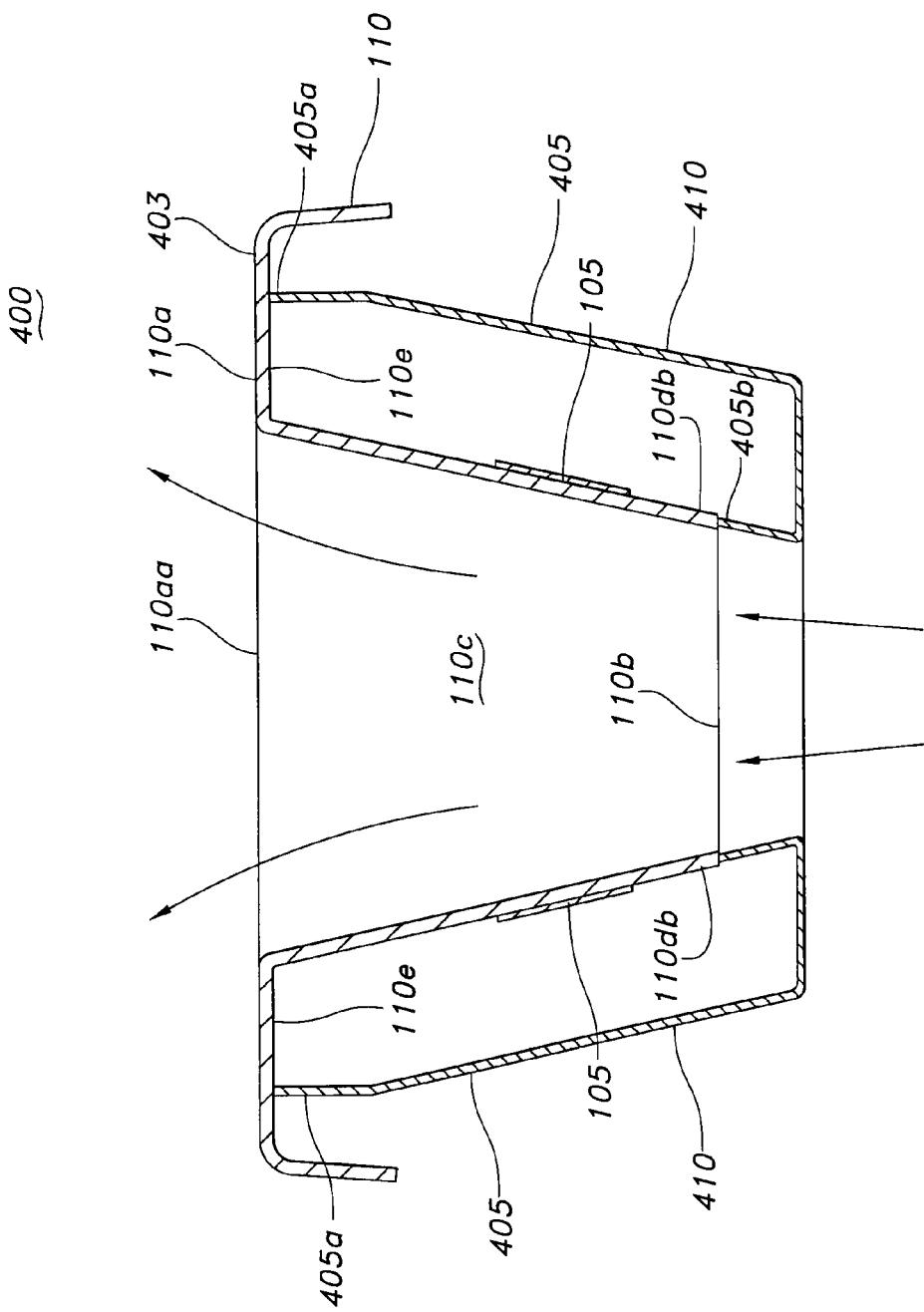


FIG. 4

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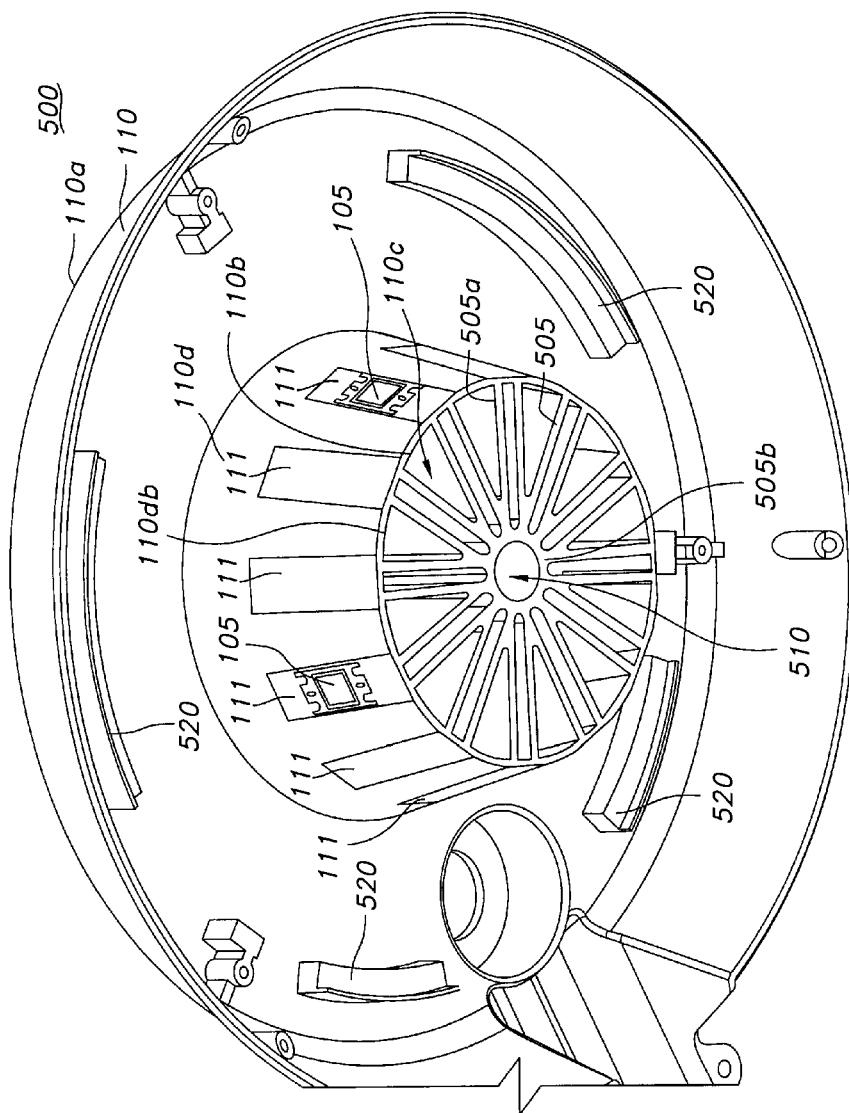


FIG. 5

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**HEAT MANAGEMENT FOR A LIGHT
FIXTURE WITH AN ADJUSTABLE OPTICAL
DISTRIBUTION**

RELATED APPLICATION

This patent application is a continuation of U.S. patent application Ser. No. 12/183,490 filed on Jul. 31, 2008, now U.S. Pat. No. 7,874,700 which claims priority under 35 U.S.C. §119 to U.S. Provisional Patent Application No. 60/994,371, titled "Flexible Light Emitting Diode Optical Distribution," filed Sep. 19, 2007. In addition, this patent application is related to U.S. patent application Ser. No. 12/183,499 titled "Light Fixture With An Adjustable Optical Distribution," filed Jul. 31, 2008. The complete disclosure of each of the foregoing priority and related applications is hereby fully incorporated herein by reference.

TECHNICAL FIELD

The invention relates generally to light fixtures and more particularly to light fixtures with adjustable optical distributions.

BACKGROUND

A luminaire is a system for producing, controlling, and/or distributing light for illumination. For example, a luminaire includes a system that outputs or distributes light into an environment, thereby allowing certain items in that environment to be visible. Luminaires are used in indoor or outdoor applications.

A typical luminaire includes one or more light emitting elements, one or more sockets, connectors, or surfaces configured to position and connect the light emitting elements to a power supply, an optical device configured to distribute light from the light emitting elements, and mechanical components for supporting or suspending the luminaire. Luminaires are sometimes referred to as "lighting fixtures" or as "light fixtures." A light fixture that has a socket, connector, or surface configured to receive a light emitting element, but no light emitting element installed therein, is still considered a luminaire. That is, a light fixture lacking some provision for full operability may still fit the definition of a luminaire. The term "light emitting element" is used herein to refer to any device configured to emit light, such as a lamp or a light-emitting diode ("LED").

Optical devices are configured to direct light energy emitted by light emitting elements into one or more desired areas. For example, optical devices may direct light energy through reflection, diffusion, baffling, refraction, or transmission through a lens. Lamp placement within the light fixture also plays a significant role in determining light distribution. For example, a horizontal lamp orientation typically produces asymmetric light distribution patterns, and a vertical lamp orientation typically produces a symmetric light distribution pattern.

Different lighting applications require different optical distributions. For example, a lighting application in a large, open environment may require a symmetric, square distribution that produces a wide, symmetrical pattern of uniform light. Another lighting application in a smaller or narrower environment may require a non-square distribution that produces a focused pattern of light. For example, the amount and direction of light required from a light fixture used on a street pole depends on the location of the pole and the intended environment to be illuminated.

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Traditional light fixtures are configured to only output light in a single, predetermined distribution. To change an optical distribution in a given environment, a person must uninstall an existing light fixture and install a new light fixture with a different optical configuration. These steps are cumbersome, time consuming, and expensive.

Therefore, a need exists in the art for an improved means for adjusting optical distribution of a light fixture. In particular, a need exists in the art for efficient, user-friendly, and cost-effective systems and methods for adjusting light emitting diode optical distribution of a light fixture.

SUMMARY

The invention provides an improved means for adjusting optical distribution of a light fixture. In particular, the invention provides a light fixture with an adjustable optical distribution. The light fixture can be used in indoor and/or outdoor applications.

The light fixture includes a member having multiple surfaces disposed at least partially around a channel extending through the member. The member can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member can have a frusto-conical or cylindrical shape.

Each surface is configured to receive at least one LED. For example, each surface can receive one or more LEDs in a linear or non-linear array. Each surface can be integral to the member or coupled thereto. For example, the surfaces can be formed on the member via molding, casting, extrusion, or die-based material processing. Alternatively, the surfaces can be mounted or attached to the member by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other fastening means.

Each LED can be removably coupled to a respective one of the surfaces. For example, each LED can be mounted to its respective surface via a substrate that includes one or more sheets of ceramic, metal, laminate, or another material. The optical distribution of the light fixture can be adjusted by changing the output direction and/or intensity of one or more of the LEDs. In other words, the optical distribution of the light fixture can be adjusted by mounting additional LEDs to certain surfaces, removing LEDs from certain surfaces, and/or by changing the position and/or configuration of one or more of the LEDs across the surfaces or along particular surfaces. For example, one or more of the LEDs can be repositioned along a different surface, repositioned in a different location along the same surface, removed from the member, or reconfigured to have a different level of electric power to adjust the optical distribution of the light fixture. A given light fixture can be adjusted to have any number of optical distributions. Thus, the light fixture provides flexibility in establishing and adjusting optical distribution.

As a byproduct of converting electricity into light, LEDs generate a substantial amount of heat. The member can be configured to manage heat output by the LEDs. Specifically, the channel extending through the member is configured to transfer the heat output from the LEDs by convection. Heat from the LEDs is transferred to the surfaces by conduction and to the channel, which convects the heat away. For example, the channel can transfer heat by the venturi effect.

The shape of the channel can correspond to the shape of the member. For example, if the member has a frusto-conical shape, the channel can have a wide top end and a narrower bottom end. Alternatively, the shape of the channel can be independent of the shape of the member.

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Fins can be disposed within the channel to assist with the heat transfer. For example, the fins can extend from the surfaces into the channel, towards a core region of the member. The core region can include a point where the fins converge. In addition, or in the alternative, the core region can include a member disposed within and extending along the channel and having a shape defining a second, inner channel that extends through the member. The fins can be configured to transfer heat by conduction from the facets to the inner channel. Like the outer channel, the inner channel can be configured to transfer at least a portion of that heat through convection. This air movement assists in dissipating heat generated by the LEDs.

These and other aspects, features and embodiments of the invention will become apparent to a person of ordinary skill in the art upon consideration of the following detailed description of illustrated embodiments exemplifying the best mode for carrying out the invention as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description, in conjunction with the accompanying figures briefly described as follows.

FIG. 1 is a perspective view of a light fixture with an optical distribution capable of being adjusted, according to certain exemplary embodiments.

FIG. 2 is another perspective view of the exemplary light fixture of FIG. 1, wherein the light fixture has a different optical distribution than that illustrated in FIG. 1.

FIG. 3 is a side elevational view of a light fixture with an optical distribution capable of being adjusted, according to certain alternative exemplary embodiments.

FIG. 4 is a cross-sectional side view of a light fixture with an optical distribution capable of being adjusted, according to another alternative exemplary embodiment.

FIG. 5 is a perspective view of a light fixture with an optical distribution capable of being adjusted, according to yet another alternative exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The present invention is directed to systems for adjusting optical distribution of a light fixture. In particular, the invention provides efficient, user-friendly, and cost-effective systems for adjusting optical distribution of a light fixture. The term “optical distribution” is used herein to refer to the spatial or geographic dispersion of light within an environment, including a relative intensity of the light within one or more regions of the environment.

Turning now to the drawings, in which like numerals indicate like elements throughout the figures, exemplary embodiments of the invention are described in detail. FIG. 1 is a perspective view of a light fixture 100 with an optical distribution capable of being adjusted, according to certain exemplary embodiments. FIG. 2 is another perspective view of the light fixture 100, wherein the light fixture 100 has a different optical distribution than that illustrated in FIG. 1. With reference to FIGS. 1 and 2, the light fixture 100 is an electrical device configured to create artificial light or illumination in an indoor and/or outdoor environment. For example, the light fixture 100 is suited for mounting to a pole (not shown) or similar structure, for use as a street light.

In the exemplary embodiments depicted in FIGS. 1 and 2, the light fixture 100 is configured to create artificial light or

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illumination via one or more LEDs 105. Each LED 105 is mounted to an outer surface 111 of a housing 110. The housing 110 includes a top end 110a and a bottom end 110b. Each end 110a and 110b includes an aperture 110aa (FIG. 4) and 110ba, respectively. A channel 110c extends through the housing 110 and connects the apertures 110aa and 110ba. The top end 110a includes a substantially round top surface 110ab disposed around the channel 110c. A mounting member 111ac extends outward from the top surface 110ab, in a direction away from the channel 110c. The mounting member 111ac is configured to be coupled to the pole, for mounting the light fixture 100 thereto.

In certain exemplary embodiments, a light-sensitive phototocell 310 is coupled to the mounting member 111ac. The phototocell 310 is configured to change electrical resistance in a circuit that includes one or more of the LEDs 105, based on incident light intensity. For example, the phototocell 310 can cause the LEDs 105 to output light at dusk but not to output light at dawn.

A member 110d extends downward from the top surface 110ab, around the channel 110c. The member 110d has a frusto-conical geometry, with a top end 110da and a bottom end 110db that has a diameter that is less than a diameter of the top end 110da. Each outer surface 111 includes a substantially flat, curved, angular, textured, recessed, protruding, bulbous, and/or other-shaped surface disposed along an outer perimeter of the member 110d. For simplicity, each outer surface 111 is referred to herein as a “facet.” The LEDs 105 can be mounted to the facets 111 by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other means known to a person of ordinary skill in the art having the benefit of the present disclosure.

In the exemplary embodiments depicted in FIGS. 1 and 2, the housing 110 includes twenty facets 111. The number of facets 111 can vary depending on the size of the LEDs 105, the size of the housing 110, cost considerations, and other financial, operational, and/or environmental factors known to a person of ordinary skill in the art having the benefit of the present disclosure. As will be readily apparent to a person of ordinary skill in the art, a larger number of facets 111 corresponds to a higher level of flexibility in adjusting the optical distribution of the light fixture 100. In particular, as described below, each facet 111 is configured to receive one or more LEDs 105 in one or more positions. The greater the number of facets 111 present on the member 110d, the greater the number of LED 105 positions, and thus optical distributions, available.

In the embodiments depicted in FIGS. 1 and 2, the end 110a and member 110d are integral to the housing 110, and the facets 111 are integral to the member 110d. In certain exemplary embodiments, the housing 110 and/or the end 110a, member 110d, and/or facets 111 thereof can be formed via molding, casting, extrusion, or die-based material processing. For example, the housing 110 and facets 111 can be comprised of die-cast aluminum. In certain alternative exemplary embodiments, the end 110a, member 110d, and/or facets 111 include separate components coupled together to form the housing 110. For example, the facets 111 can be mounted or attached to the member 110d by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other attachment means known to a person of ordinary skill in the art having the benefit of the present disclosure.

Each facet 111 is configured to receive a column of one or more LEDs 105. The term “column” is used herein to refer to an arrangement or a configuration whereby one or more LEDs 105 are disposed approximately in or along a line.

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LEDs **105** in a column are not necessarily in perfect alignment with one another. For example, one or more LEDs **105** in a column might be slightly out of perfect alignment due to manufacturing tolerances or assembly deviations. In addition, LEDs **105** in a column might be purposely staggered in a non-linear arrangement. Each column extends along an axis of its associated facet **111**.

In certain exemplary embodiments, each LED **105** is mounted to its corresponding facet **111** via a substrate **105a**. Each substrate **105a** includes one or more sheets of ceramic, metal, laminate, or another material. Each LED **105** is attached to its respective substrate **105a** by a solder joint, a plug, an epoxy or bonding line, or another suitable provision for mounting an electrical/optical device on a surface. Each substrate **105a** is connected to support circuitry (not shown) or a driver (not shown) for supplying electrical power and control to the associated LED **105**. The support circuitry (not shown) includes one or more transistors, operational amplifiers, resistors, controllers, digital logic elements, or the like for controlling and powering the LED **105**.

In certain exemplary embodiments, the LEDs **105** include semiconductor diodes configured to emit incoherent light when electrically biased in a forward direction of a p-n junction. For example, each LED **105** can emit blue or ultraviolet light. The emitted light can excite a phosphor that in turn emits red-shifted light. The LEDs **105** and the phosphors can collectively emit blue and red-shifted light that essentially matches blackbody radiation. The emitted light approximates or emulates incandescent light to a human observer. In certain exemplary embodiments, the LEDs **105** and their associated phosphors emit substantially white light that may seem slightly blue, green, red, yellow, orange, or some other color or tint. Exemplary embodiments of the LEDs **105** can include indium gallium nitride ("InGaN") or gallium nitride ("GaN") for emitting blue light.

In certain exemplary embodiments, one or more of the LEDs **105** includes multiple LED elements (not shown) mounted together on a single substrate **105a**. Each of the LED elements can produce the same or a distinct color of light. The LED elements can collectively produce substantially white light or light emulating a blackbody radiator. In certain exemplary embodiments, some of the LEDs **105** produce one color of light while others produce another color of light. Thus, in certain exemplary embodiments, the LEDs **105** provide a spatial gradient of colors.

In certain exemplary embodiments, optically transparent or clear material (not shown) encapsulates each LED **105** and/or LED element, either individually or collectively. This material provides environmental protection while transmitting light. For example, this material can include a conformal coating, a silicone gel, cured/curable polymer, adhesive, or some other material known to a person of ordinary skill in the art having the benefit of the present disclosure. In certain exemplary embodiments, phosphors configured to convert blue light to light of another color are coated onto or dispersed in the encapsulating material.

The optical distribution of the light fixture **100** depends on the positioning and configuration of the LEDs **105** within the facets **111**. For example, as illustrated in FIG. 1 and FIG. 3, described below, positioning multiple LEDs **105** symmetrically along the outer perimeter of the member **110d**, in a polar array, can create a type V symmetric distribution of light. Outdoor area and roadway luminaires are designed to distribute light over different areas, classified with designations I, II, III, IV, and V. Generally, type II distributions are wide, asymmetric light patterns used to light narrow roadways (i.e. 2 lanes) from the edge of the roadway. Type III asymmetric

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distributions are not quite as wide as type II distributions but throw light further forward for wider roadways (i.e. 3 lanes). Similarly, a type IV asymmetric distribution is not as wide as the type III distribution but distributes light further forward for wider roadways (4 lanes) or perimeters of parking lots. A type V distribution produces a symmetric light pattern directly below the luminaire, typically either a round or square pattern of light. For example, positioning LEDs **105** only in three adjacent facets **111** can create a type IV asymmetric distribution of light.

As illustrated in FIG. 2, positioning multiple LEDs **105** in the same facet **111** increases directional intensity of the light relative to the facet **111** (as compared to a facet **111** with only one or no LEDs **105**). For example, positioning the LEDs **105** in a linear array **205** along the facet **111** increases directional intensity of the light substantially normal to the axis of the facet **111**. Directional intensity also can be adjusted by increasing or decreasing the electric power to one or more of the LEDs **105**. For example, overdriving one or more LEDs **105** increases the directional intensity of the light from the LEDs **105** in a direction normal to the corresponding facet **111**. Similarly, using LEDs **105** with different sizes and/or wattages can adjust directional intensity. For example, replacing an LED **105** with another LED **105** that has a higher wattage can increase the directional intensity of the light from the LEDs **105** in a direction normal to the corresponding facet **111**.

The optical distribution of the light fixture **100** can be adjusted by changing the output direction and/or intensity of one or more of the LEDs **105**. In other words, the optical distribution of the light fixture **100** can be adjusted by mounting additional LEDs **105** to the member **110d**, removing LEDs **105** from the member **110d**, and/or by changing the position and/or configuration of one or more of the LEDs **105**. For example, one or more of the LEDs **105** can be repositioned in a different facet **111**, repositioned in a different location within the same facet **111**, removed from the light fixture **100**, or reconfigured to have a different level of electric power. A given light fixture **100** can be adjusted to have any number of optical distributions.

For example, if a particular lighting application only requires light to be emitted towards one direction, LEDs **105** can be placed only on facets **111** corresponding to that direction. If the intensity of the emitted light in that direction is too low, the electric power to the LEDs **105** may be increased, and/or additional LEDs **105** may be added to those facets **111**. Similarly, if the intensity of the emitted light in that direction is too high, the electric power to the LEDs **105** may be decreased, and/or one or more of the LEDs **105** may be removed from the facets **111**. If the lighting application changes to require a larger beam spread of light in multiple directions, additional LEDs **105** can be placed on empty, adjacent facets **111**. In addition, the beam spread may be tightened by moving one or more of the LEDs **105** downward within their respective facets **111**, towards the bottom end **110db**. Similarly, the beam spread may be broadened by moving one or more of the LEDs **105** upwards within their respective facets **111**, towards the top end **110da**. Thus, the light fixture **100** provides flexibility in establishing and adjusting optical distribution.

Although illustrated in FIGS. 1 and 2 as having a frustoconical geometry, a person of ordinary skill in the art having the benefit of the present disclosure will recognize that the member **110d** can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member **110d** can have a cylindrical shape. Similarly, although illustrated as having a substantially vertical orientation, each

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facet 111 may have any orientation, including, but not limited to, a horizontal or angular orientation, in certain alternative exemplary embodiments.

The level of light a typical LED 105 outputs depends, in part, upon the amount of electrical current supplied to the LED 105 and upon the operating temperature of the LED 105. Thus, the intensity of light emitted by an LED 105 changes when electrical current is constant and the LED's 105 temperature varies or when electrical current varies and temperature remains constant, with all other things being equal. Operating temperature also impacts the usable lifetime of most LEDs 105.

As a byproduct of converting electricity into light, LEDs 105 generate a substantial amount of heat that raises the operating temperature of the LEDs 105 if allowed to accumulate on the LEDs 105, resulting in efficiency degradation and premature failure. The member 110d is configured to manage heat output by the LEDs 105. Specifically, the frusto-conical shape of the member 110d creates a venturi effect, drawing air through the channel 110c. The air travels from the bottom end 110db of the member 110d, through the channel 110c, and out the top end 110da. This air movement assists in dissipating heat generated by the LEDs 105. Specifically, the air dissipates the heat away from the member 110d and the LEDs 105 thereon. Thus, the member 110d acts as a heat sink for the LEDs 105 positioned within or along the facets 111.

FIG. 3 is a side elevational view of a light fixture 300 with an optical distribution capable of being adjusted. The light fixture 300 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 300 includes a cover 305. The cover 305 is an optically transmissive element that provides protection from dirt, dust, moisture, and the like. The cover 305 is disposed at least partially around the facets 111, with a top end thereof being coupled to the top surface 110ab of the housing 110. In certain exemplary embodiments, the cover 305 is configured to control light from the LEDs 105 via refraction, diffusion, or the like. For example, the cover 305 can include a refractor, a lens, an optic, or a milky plastic or glass element.

FIG. 4 is a cross-sectional side view of a light fixture 400 with an optical distribution capable of being adjusted, according to another alternative exemplary embodiment. Like the light fixture 300 of FIG. 3, the light fixture 400 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 400 includes a cover 405. The cover 405 includes an optically transmissive element 410 that provides protection from dirt, dust, moisture, and the like. The cover 405 is disposed at least partially around the facets 111, with a top end 405a thereof being attached to a bottom surface 110e of the top end 110a of the housing 110. For example, the top end 405a can be attached to one or more ledges 520 (shown in FIG. 5) extending from the bottom surface 110e of the housing 110. Another end 405b of the cover 405 is attached to the bottom end 110db of the member 110d. In certain exemplary embodiments, there is a sealing element (not shown) between the cover 405 and the member 110d, at one or more points of attachment. In certain exemplary embodiments, the cover 405 is configured to control light from the LEDs 105 via refraction, diffusion, or the like. For example, the cover 405 can include a refractor, a lens, an optic, or a milky plastic or glass element.

FIG. 5 is a perspective view of a light fixture 500 with an optical distribution capable of being adjusted, according to yet another alternative exemplary embodiment. The light fixture 500 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 500 includes one or more fins 505 acting as heat sinks for managing heat produced by the LEDs

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105. In certain exemplary embodiments, each fin 505 is associated with a facet 111 and includes an elongated member 505a that extends from an interior surface (of the member 110d) opposite its associated facet 111, within the channel 110c, to a core region 505b. A channel 510 extends through the core region 505b, within the channel 110c. The fins 505 are spaced annularly around the channel 510. Alternatively, one or more of the fins 505 can be independent of the facets 111 and can be positioned radially in a symmetrical or non-symmetrical pattern.

Heat transfers from the LEDs 105 via a heat-transfer path extending from the LEDs 105, through the member 110d, and to the fins 505. For example, the heat 105 from a particular LED 105 transfers from the substrate 105a of the LED 105 to its corresponding facet 111, and from the facet 111 through the member 110d to the corresponding fin 505. The fins 505 receive the conducted heat and transfer the conducted heat to the surrounding environment (typically air) via convection.

The channel 510 supports convection-based cooling. For example, as described above in connection with FIGS. 1 and 2, the frusto-conical shape of the member 110d creates a venturi effect, drawing air through the channel 510. The air travels from the bottom end 110b of the housing 110, through the channel 510, and out the top end 110a. This air movement assists in dissipating heat generated by the LEDs 105 away from the LEDs 105. In certain alternative exemplary embodiments, the fins 505 converge within the channel 110c so that there is not an inner channel 510 within the channel 110c. In such an embodiment, the channel 110c supports convection-based cooling substantially as described above.

In the embodiment depicted in FIG. 5, the fins 505 are integral to the member 110d. In certain exemplary embodiments, the fins 505 can be formed on the member 110d via molding, casting, extrusion, or die-based material processing. For example, the member 110d and fins 505 can be comprised of die-cast aluminum. Alternatively, the fins 505 can be mounted or attached to the member 110d by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other fastening means known to a person of ordinary skill in the art having the benefit of the present disclosure. Like the light fixtures 300 and 400 of FIGS. 3 and 4, respectively, in certain alternative exemplary embodiments, the light fixture 500 can be modified to include a cover (not shown).

Although illustrated in FIG. 5 as having a frusto-conical geometry, a person of ordinary skill in the art having the benefit of the present disclosure will recognize that the member 110d can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member 110d can have a cylindrical shape.

Although specific embodiments of the invention have been described above in detail, the description is merely for purposes of illustration. It should be appreciated, therefore, that many aspects of the invention were described above by way of example only and are not intended as required or essential elements of the invention unless explicitly stated otherwise. Various modifications of, and equivalent steps corresponding to, the disclosed aspects of the exemplary embodiments, in addition to those described above, can be made by a person of ordinary skill in the art, having the benefit of this disclosure, without departing from the spirit and scope of the invention defined in the following claims, the scope of which is to be accorded the broadest interpretation so as to encompass such modifications and equivalent structures.

What is claimed is:

1. A light fixture, comprising:
a member comprising:

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a top end comprising a first aperture;
 a bottom end comprising a second aperture,
 a channel extending from the first aperture to the second
 aperture and defined by an interior surface of the
 member;
 a plurality of light emitting diodes (LEDs) disposed on the
 fixture adjacent to the channel, wherein at least one LED
 is located on one side of the channel and at least another
 LED is located on an opposite side of the channel;
 wherein air enters the channel through the second aperture 10
 and exits the channel through the first aperture; and
 wherein the LEDs transfer heat through the member to the
 air in the channel.

2. The light fixture of claim 1, wherein the at least one LED
 and the at least another LED are positioned co-planar to each
 other. 15

3. The light fixture of claim 1, further comprising a plurality
 of LED receiving surfaces, wherein the LED receiving
 surfaces are disposed at least partially around the channel.

4. The light fixture of claim 1, further comprising a mount-
 ing member extending outwardly in a direction substantially
 orthogonal to a longitudinal axis of the channel. 20

5. The light fixture of claim 1, wherein the member further
 comprises:
 a core region extending centrally along at least a portion of 25
 the channel; and

one or more fins extending radially outward from the core
 region.

6. The light fixture of claim 1, further comprising an opti-
 cally transmissive cover disposed at least partially around the
 member. 30

7. The light fixture of claim 1, wherein the plurality of
 LEDs are asymmetrically disposed about the channel and
 configured to emit an asymmetric light output.

8. The light fixture of claim 1, further comprising
 a driver electrically coupled to at least one of the plurality
 of LEDs to control the at least one of the plurality of
 LEDs; and
 a photocell electrically coupled to the driver. 35

9. The light fixture of claim 1 further comprising a plurality
 of receiving surfaces, each receiving surface configured to
 receive at least one LED and wherein the plurality of receiv-
 ing surfaces provide a plurality of different configuration for
 a positioning of the plurality of LEDs, each of the plurality of
 different configuration corresponding to a different optical
 distribution of the light fixture. 40

10. The light fixture of claim 9, wherein the plurality of
 receiving surfaces are provided on an outer surface of the
 interior surface of the member. 45

11. The light fixture of claim 1, wherein the second aper-
 ture is smaller than the first aperture. 50

12. A light fixture, comprising:
 a member comprising:

an interior surface;

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an exterior surface;
 a first aperture disposed along a first end;
 a second aperture disposed along a distal second end;
 a channel extending from the first aperture to the second
 aperture and defined by the interior surface; and

a plurality of light emitting diodes (LEDs) positioned adjac-
 ent to the channel; wherein a first of the plurality of
 LEDs is disposed adjacent a first portion of the channel
 and a second of the plurality of LEDs is disposed adjac-
 ent a second portion of the channel different than the
 first portion; and

wherein air passes through the channel from the second
 aperture to the first aperture and transfers at least a
 portion of heat generated by the first LED and the second
 LED through the first aperture.

13. The light fixture of claim 12, wherein the first LED and
 the second LED are positioned co-planar to each other.

14. The light fixture of claim 12, further comprising a
 mounting member extending outwardly from the member in
 a direction away from a longitudinal axis of the channel. 20

15. The light fixture of claim 12, wherein the heat is trans-
 ferred from the first and second LED to the member by
 conduction; and

wherein the heat is transferred from the member through
 the channel with the air by convection.

16. The light fixture of claim 12, wherein the first aperture
 has a first diameter and the second aperture has a second
 diameter and wherein the first and second diameters are dif-
 ferent.

17. A light fixture, comprising:
 a member comprising:

an interior surface
 a first aperture;
 a second distal aperture,
 a channel through the member extending from the first
 aperture to the second aperture and defined by the
 interior surface of the member;
 at least one first light emitting diode (LED) coupled adjac-
 ent a first side of the channel;
 at least one second LED coupled adjacent a second side of
 the channel;
 wherein air enters the channel and transfers at least a por-
 tion of the heat generated by the first and second LEDs
 through the first aperture.

18. The light fixture of claim 17, wherein the second side of
 the channel is opposite the first side of the channel.

19. The light fixture of claim 17, wherein the channel is
 configured to transfer at least the portion of the heat generated
 by the first and second LEDs by venturi effect.

20. The light fixture of claim 17, wherein the first and
 second LEDs are in thermal communication with the member
 and configured to transfer heat to the member by convection.

* * * * *

EXHIBIT 2



US009163807B2

(12) **United States Patent**
Patrick

(10) **Patent No.:** US 9,163,807 B2
(45) **Date of Patent:** Oct. 20, 2015

(54) **HEAT MANAGEMENT FOR A LIGHT FIXTURE WITH AN ADJUSTABLE OPTICAL DISTRIBUTION**

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(21) Appl. No.: **14/605,880**

(22) Filed: **Jan. 26, 2015**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation of application No. 13/600,790, filed on Aug. 31, 2012, now Pat. No. 8,939,608, which is a continuation of application No. 12/961,315, filed on Dec. 6, 2010, now Pat. No. 8,256,923, which is a continuation of application No. 12/183,490, filed on Jul. 31, 2008, now Pat. No. 7,874,700.

(60) Provisional application No. 60/994,371, filed on Sep. 19, 2007.

(51) **Int. Cl.**

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F21V 29/503 (2015.01)
F21V 29/83 (2015.01)
F21Y 101/02 (2006.01)

(52) **U.S. Cl.**

CPC **F21V 14/02** (2013.01); **F21V 29/503** (2015.01); **F21V 29/83** (2015.01); **F21Y 2101/02** (2013.01)

(58) **Field of Classification Search**

CPC F21V 14/02; F21V 29/83; F21V 29/503
USPC 362/545, 226, 231, 247, 800
See application file for complete search history.

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Primary Examiner — Anne Hines

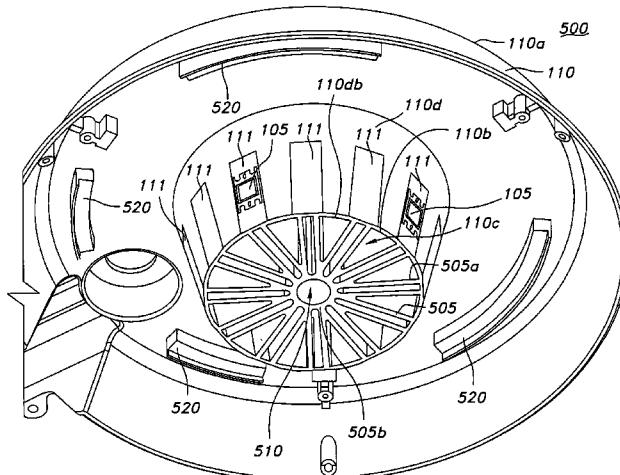
(74) *Attorney, Agent, or Firm* — King & Spalding LLP

(57)

ABSTRACT

A light fixture includes a member having a substantially frusto-conical shape. A channel extends between a wide top end of the member and a narrower bottom end of the member. The member includes multiple surfaces (“facets”) disposed around its outer surface. Each facet is configured to receive one or more light emitting diodes (“LEDs”) in a linear or non-linear array. Each facet can be integral to the member or coupled to the member. The channel is configured to transfer heat generated by the LEDs through convection. Fins can be disposed within the channel, extending from the inner surface of the member to an inner channel. The fins are configured to transfer heat away from, and provide a greater surface area for convecting heat away from, the member. For example, one or both of the channels can transfer heat by a venturi effect.

20 Claims, 5 Drawing Sheets



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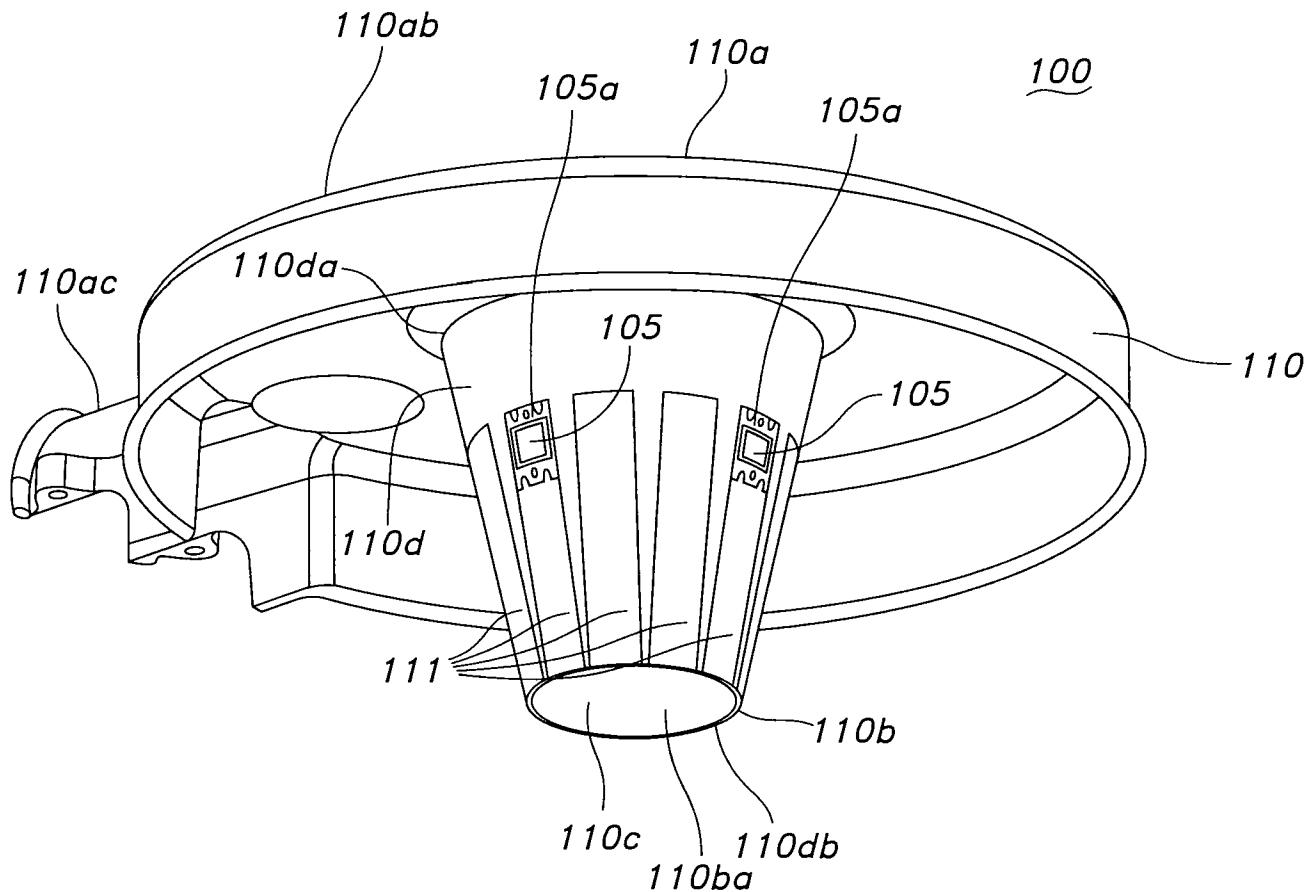


FIG. 1

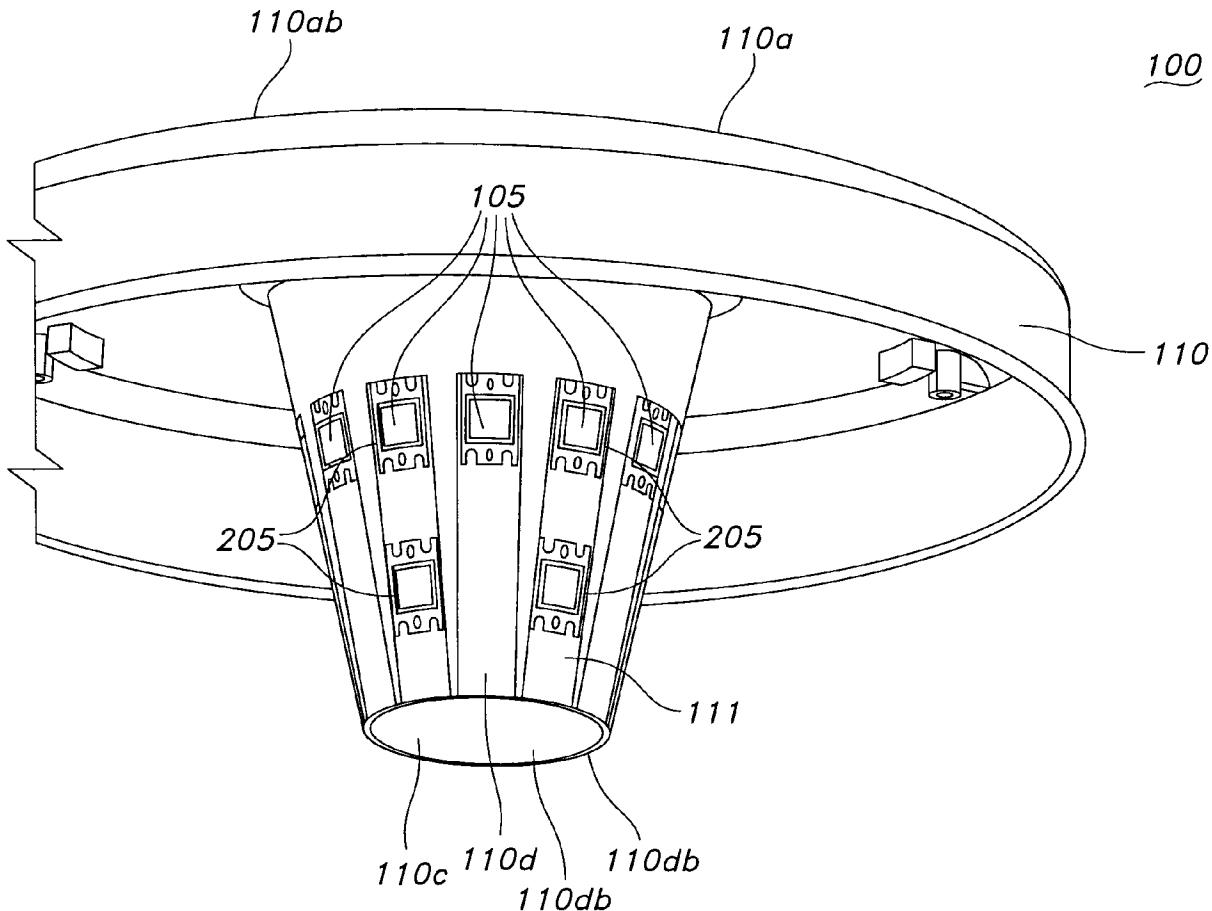


FIG. 2

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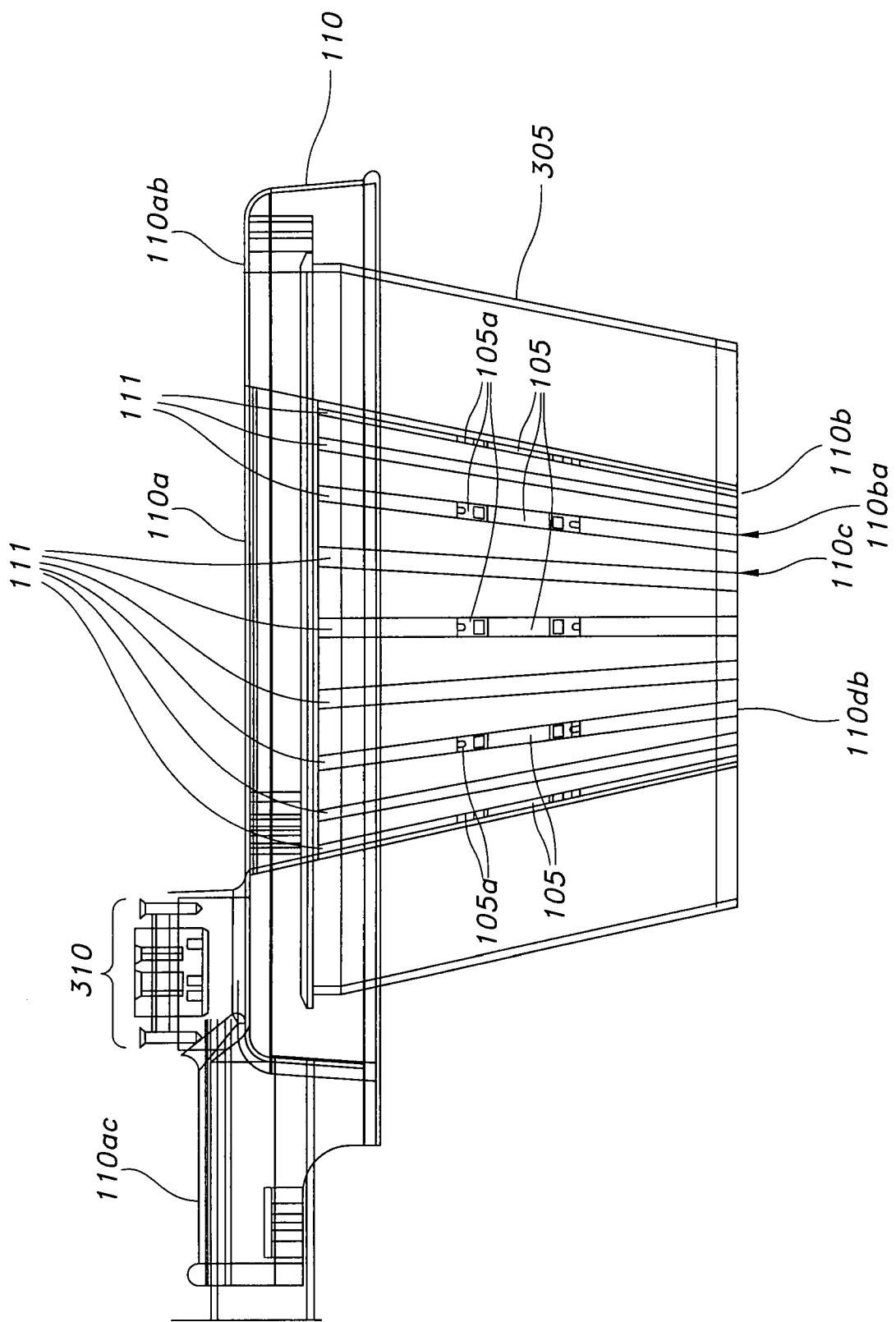


FIG. 3

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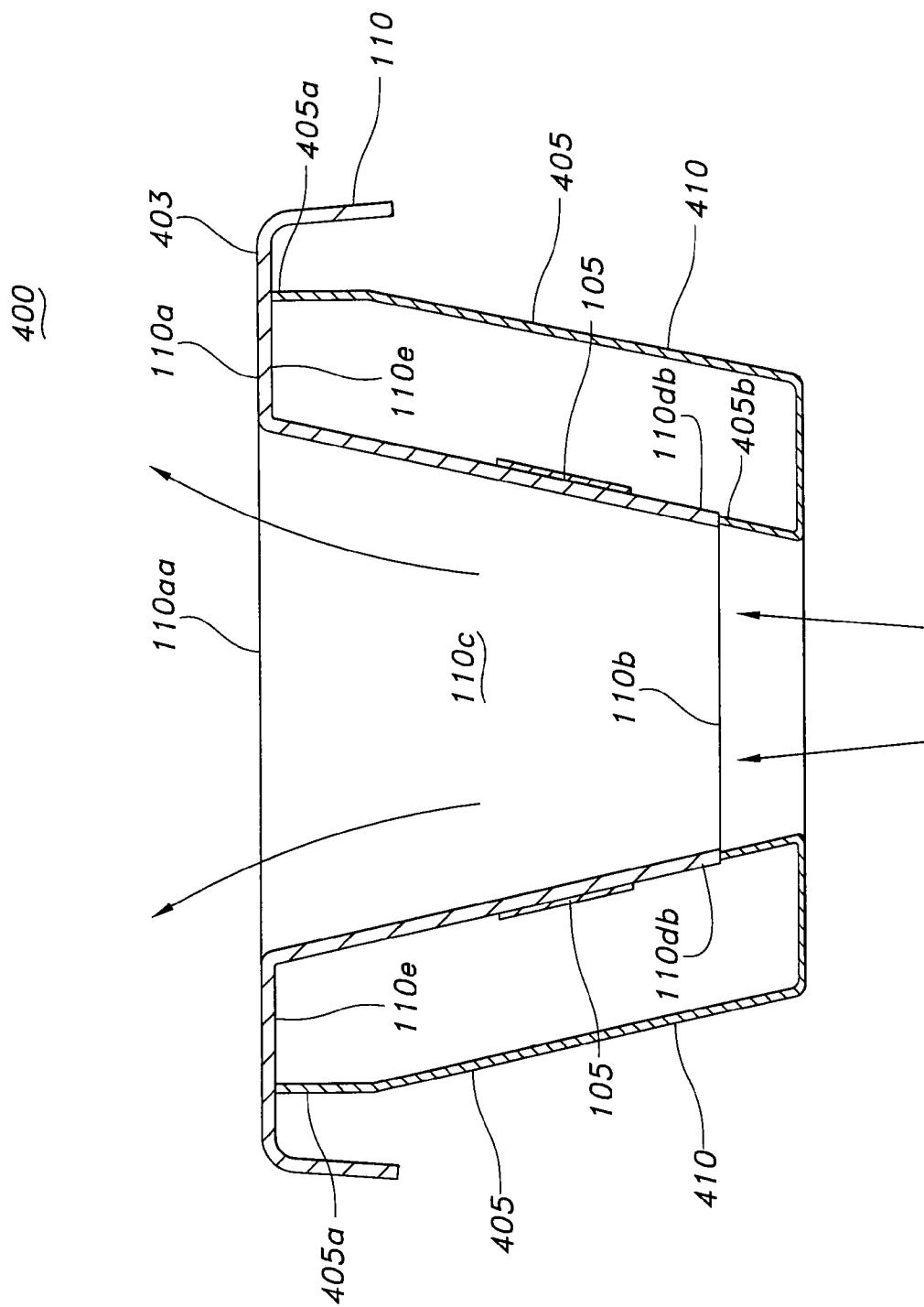


FIG. 4

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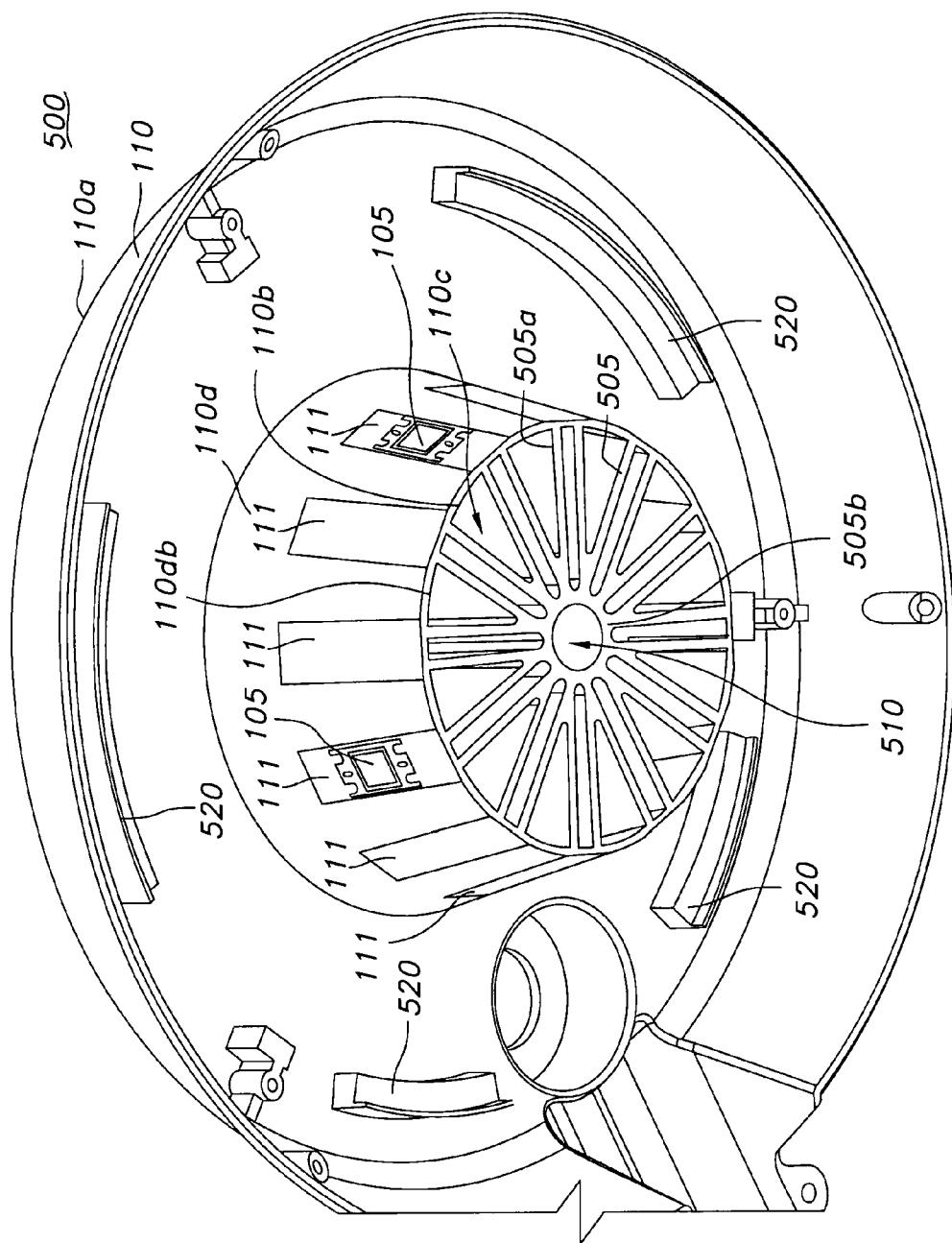


FIG. 5

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**HEAT MANAGEMENT FOR A LIGHT
FIXTURE WITH AN ADJUSTABLE OPTICAL
DISTRIBUTION**

RELATED APPLICATIONS

This patent application is a continuation of and claims priority to U.S. patent application Ser. No. 13/600,790 filed on Aug. 31, 2012 which is a continuation of and claims priority to U.S. patent application Ser. No. 12/961,315 filed on Dec. 6, 2010, which is a continuation of and claims priority under 35 U.S.C. §120 to U.S. patent application Ser. No. 12/183,490 filed on Jul. 31, 2008, which claims priority under 35 U.S.C. §119 to U.S. Provisional Patent Application No. 60/994,371, titled "Flexible Light Emitting Diode Optical Distribution," filed Sep. 19, 2007. In addition, this patent application is related to U.S. patent application Ser. No. 12/183,499 titled "Light Fixture With An Adjustable Optical Distribution," filed Jul. 31, 2008. The complete disclosure of each of the foregoing priority and related applications is hereby fully incorporated by reference herein.

TECHNICAL FIELD

The invention relates generally to light fixtures and more particularly to light fixtures with adjustable optical distributions.

BACKGROUND

A luminaire is a system for producing, controlling, and/or distributing light for illumination. For example, a luminaire includes a system that outputs or distributes light into an environment, thereby allowing certain items in that environment to be visible. Luminaires are used in indoor or outdoor applications.

A typical luminaire includes one or more light emitting elements, one or more sockets, connectors, or surfaces configured to position and connect the light emitting elements to a power supply, an optical device configured to distribute light from the light emitting elements, and mechanical components for supporting or suspending the luminaire. Luminaires are sometimes referred to as "lighting fixtures" or as "light fixtures." A light fixture that has a socket, connector, or surface configured to receive a light emitting element, but no light emitting element installed therein, is still considered a luminaire. That is, a light fixture lacking some provision for full operability may still fit the definition of a luminaire. The term "light emitting element" is used herein to refer to any device configured to emit light, such as a lamp or a light emitting diode ("LED").

Optical devices are configured to direct light energy emitted by light emitting elements into one or more desired areas. For example, optical devices may direct light energy through reflection, diffusion, baffling, refraction, or transmission through a lens. Lamp placement within the light fixture also plays a significant role in determining light distribution. For example, a horizontal lamp orientation typically produces asymmetric light distribution patterns, and a vertical lamp orientation typically produces a symmetric light distribution pattern.

Different lighting applications require different optical distributions. For example, a lighting application in a large, open environment may require a symmetric, square distribution that produces a wide, symmetrical pattern of uniform light. Another lighting application in a smaller or narrower environment may require a non-square distribution that produces

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a focused pattern of light. For example, the amount and direction of light required from a light fixture used on a street pole depends on the location of the pole and the intended environment to be illuminated.

Traditional light fixtures are configured to only output light in a single, predetermined distribution. To change an optical distribution in a given environment, a person must uninstall an existing light fixture and install a new light fixture with a different optical configuration. These steps are cumbersome, time consuming, and expensive.

Therefore, a need exists in the art for an improved means for adjusting optical distribution of a light fixture. In particular, a need exists in the art for efficient, user-friendly, and cost-effective systems and methods for adjusting light emitting diode optical distribution of a light fixture.

SUMMARY

The invention provides an improved means for adjusting optical distribution of a light fixture. In particular, the invention provides a light fixture with an adjustable optical distribution. The light fixture can be used in indoor and/or outdoor applications.

The light fixture includes a member having multiple surfaces disposed at least partially around a channel extending through the member. The member can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member can have a frusto-conical or cylindrical shape.

Each surface is configured to receive at least one LED. For example, each surface can receive one or more LEDs in a linear or non-linear array. Each surface can be integral to the member or coupled thereto. For example, the surfaces can be formed on the member via molding, casting, extrusion, or die-based material processing. Alternatively, the surfaces can be mounted or attached to the member by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other fastening means.

Each LED can be removably coupled to a respective one of the surfaces. For example, each LED can be mounted to its respective surface via a substrate that includes one or more sheets of ceramic, metal, laminate, or another material. The optical distribution of the light fixture can be adjusted by changing the output direction and/or intensity of one or more of the LEDs. In other words, the optical distribution of the light fixture can be adjusted by mounting additional LEDs to certain surfaces, removing LEDs from certain surfaces, and/or by changing the position and/or configuration of one or more of the LEDs across the surfaces or along particular surfaces. For example, one or more of the LEDs can be repositioned along a different surface, repositioned in a different location along the same surface, removed from the member, or reconfigured to have a different level of electric power to adjust the optical distribution of the light fixture. A given light fixture can be adjusted to have any number of optical distributions. Thus, the light fixture provides flexibility in establishing and adjusting optical distribution.

As a byproduct of converting electricity into light, LEDs generate a substantial amount of heat. The member can be configured to manage heat output by the LEDs. Specifically, the channel extending through the member is configured to transfer the heat output from the LEDs by convection. Heat from the LEDs is transferred to the surfaces by conduction and to the channel, which convects the heat away. For example, the channel can transfer heat by the venturi effect.

The shape of the channel can correspond to the shape of the member. For example, if the member has a frusto-conical

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shape, the channel can have a wide top end and a narrower bottom end. Alternatively, the shape of the channel can be independent of the shape of the member.

Fins can be disposed within the channel to assist with the heat transfer. For example, the fins can extend from the surfaces into the channel, towards a core region of the member. The core region can include a point where the fins converge. In addition, or in the alternative, the core region can include a member disposed within and extending along the channel and having a shape defining a second, inner channel that extends through the member. The fins can be configured to transfer heat by conduction from the facets to the inner channel. Like the outer channel, the inner channel can be configured to transfer at least a portion of that heat through convection. This air movement assists in dissipating heat generated by the LEDs.

These and other aspects, features and embodiments of the invention will become apparent to a person of ordinary skill in the art upon consideration of the following detailed description of illustrated embodiments exemplifying the best mode for carrying out the invention as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description, in conjunction with the accompanying figures briefly described as follows.

FIG. 1 is a perspective view of a light fixture with an optical distribution capable of being adjusted, according to certain exemplary embodiments.

FIG. 2 is another perspective view of the exemplary light fixture of FIG. 1, wherein the light fixture has a different optical distribution than that illustrated in FIG. 1.

FIG. 3 is a side elevational view of a light fixture with an optical distribution capable of being adjusted, according to certain alternative exemplary embodiments.

FIG. 4 is a cross-sectional side view of a light fixture with an optical distribution capable of being adjusted, according to another alternative exemplary embodiment.

FIG. 5 is a perspective view of a light fixture with an optical distribution capable of being adjusted, according to yet another alternative exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The present invention is directed to systems for adjusting optical distribution of a light fixture. In particular, the invention provides efficient, user-friendly, and cost-effective systems for adjusting optical distribution of a light fixture. The term "optical distribution" is used herein to refer to the spatial or geographic dispersion of light within an environment, including a relative intensity of the light within one or more regions of the environment.

Turning now to the drawings, in which like numerals indicate like elements throughout the figures, exemplary embodiments of the invention are described in detail. FIG. 1 is a perspective view of a light fixture 100 with an optical distribution capable of being adjusted, according to certain exemplary embodiments. FIG. 2 is another perspective view of the light fixture 100, wherein the light fixture 100 has a different optical distribution than that illustrated in FIG. 1. With reference to FIGS. 1 and 2, the light fixture 100 is an electrical device configured to create artificial light or illumination in an indoor and/or outdoor environment. For example, the light

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fixture 100 is suited for mounting to a pole (not shown) or similar structure, for use as a street light.

In the exemplary embodiments depicted in FIGS. 1 and 2, the light fixture 100 is configured to create artificial light or illumination via one or more LEDs 105. Each LED 105 is mounted to an outer surface 111 of a housing 110. The housing 110 includes a top end 110a and a bottom end 110b. Each end 110a and 110b includes an aperture 110aa (FIGS. 4) and 110ba, respectively. A channel 110c extends through the housing 110 and connects the apertures 110aa and 110ba. The top end 110a includes a substantially round top surface 110ab disposed around the channel 110c. A mounting member 110ac extends outward from the top surface 110ab, in a direction away from the channel 110c. The mounting member 110ac is configured to be coupled to the pole, for mounting the light fixture 100 thereto.

In certain exemplary embodiments, a light-sensitive photocell 310 is coupled to the mounting member 110ac. The photocell 310 is configured to change electrical resistance in a circuit that includes one or more of the LEDs 105, based on incident light intensity. For example, the photocell 310 can cause the LEDs 105 to output light at dusk but not to output light at dawn.

A member 110d extends downward from the top surface 110ab, around the channel 110c. The member 110d has a frusto-conical geometry, with a top end 110da and a bottom end 110db that has a diameter that is less than a diameter of the top end 110da. Each outer surface 111 includes a substantially flat, curved, angular, textured, recessed, protruding, bulbous, and/or other-shaped surface disposed along an outer perimeter of the member 110d. For simplicity, each outer surface 111 is referred to herein as a "facet." The LEDs 105 can be mounted to the facets 111 by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other means known to a person of ordinary skill in the art having the benefit of the present disclosure.

In the exemplary embodiments depicted in FIGS. 1 and 2, the housing 110 includes twenty facets 111. The number of facets 111 can vary depending on the size of the LEDs 105, the size of the housing 110, cost considerations, and other financial, operational, and/or environmental factors known to a person of ordinary skill in the art having the benefit of the present disclosure. As will be readily apparent to a person of ordinary skill in the art, a larger number of facets 111 corresponds to a higher level of flexibility in adjusting the optical distribution of the light fixture 100. In particular, as described below, each facet 111 is configured to receive one or more LEDs 105 in one or more positions. The greater the number of facets 111 present on the member 110d, the greater the number of LED 105 positions, and thus optical distributions, available.

In the embodiments depicted in FIGS. 1 and 2, the end 110a and member 110d are integral to the housing 110, and the facets 111 are integral to the member 110d. In certain exemplary embodiments, the housing 110 and/or the end 110a, member 110d, and/or facets 111 thereof can be formed via molding, casting, extrusion, or die-based material processing. For example, the housing 110 and facets 111 can be comprised of die-cast aluminum. In certain alternative exemplary embodiments, the end 110a, member 110d, and/or facets 111 include separate components coupled together to form the housing 110. For example, the facets 111 can be mounted or attached to the member 110d by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other attachment means known to a person of ordinary skill in the art having the benefit of the present disclosure.

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Each facet 111 is configured to receive a column of one or more LEDs 105. The term "column" is used herein to refer to an arrangement or a configuration whereby one or more LEDs 105 are disposed approximately in or along a line. LEDs 105 in a column are not necessarily in perfect alignment with one another. For example, one or more LEDs 105 in a column might be slightly out of perfect alignment due to manufacturing tolerances or assembly deviations. In addition, LEDs 105 in a column might be purposely staggered in a non-linear arrangement. Each column extends along an axis of its associated facet 111.

In certain exemplary embodiments, each LED 105 is mounted to its corresponding facet 111 via a substrate 105a. Each substrate 105a includes one or more sheets of ceramic, metal, laminate, or another material. Each LED 105 is attached to its respective substrate 105a by a solder joint, a plug, an epoxy or bonding line, or another suitable provision for mounting an electrical/optical device on a surface. Each substrate 105a is connected to support circuitry (not shown) or a driver (not shown) for supplying electrical power and control to the associated LED 105. The support circuitry (not shown) includes one or more transistors, operational amplifiers, resistors, controllers, digital logic elements, or the like for controlling and powering the LED 105.

In certain exemplary embodiments, the LEDs 105 include semiconductor diodes configured to emit incoherent light when electrically biased in a forward direction of a p-n junction. For example, each LED 105 can emit blue or ultraviolet light. The emitted light can excite a phosphor that in turn emits red-shifted light. The LEDs 105 and the phosphors can collectively emit blue and red-shifted light that essentially matches blackbody radiation. The emitted light approximates or emulates incandescent light to a human observer. In certain exemplary embodiments, the LEDs 105 and their associated phosphors emit substantially white light that may seem slightly blue, green, red, yellow, orange, or some other color or tint. Exemplary embodiments of the LEDs 105 can include indium gallium nitride ("InGaN") or gallium nitride ("GaN") for emitting blue light.

In certain exemplary embodiments, one or more of the LEDs 105 includes multiple LED elements (not shown) mounted together on a single substrate 105a. Each of the LED elements can produce the same or a distinct color of light. The LED elements can collectively produce substantially white light or light emulating a blackbody radiator. In certain exemplary embodiments, some of the LEDs 105 produce one color of light while others produce another color of light. Thus, in certain exemplary embodiments, the LEDs 105 provide a spatial gradient of colors.

In certain exemplary embodiments, optically transparent or clear material (not shown) encapsulates each LED 105 and/or LED element, either individually or collectively. This material provides environmental protection while transmitting light. For example, this material can include a conformal coating, a silicone gel, cured/curable polymer, adhesive, or some other material known to a person of ordinary skill in the art having the benefit of the present disclosure. In certain exemplary embodiments, phosphors configured to convert blue light to light of another color are coated onto or dispersed in the encapsulating material.

The optical distribution of the light fixture 100 depends on the positioning and configuration of the LEDs 105 within the facets 111. For example, as illustrated in FIG. 1 and FIG. 3, described below, positioning multiple LEDs 105 symmetrically along the outer perimeter of the member 110d, in a polar array, can create a type V symmetric distribution of light. Outdoor area and roadway luminaires are designed to distrib-

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ute light over different areas, classified with designations I, II, III, IV, and V. Generally, type II distributions are wide, asymmetric light patterns used to light narrow roadways (i.e. 2 lanes) from the edge of the roadway. Type III asymmetric distributions are not quite as wide as type II distributions but throw light further forward for wider roadways (i.e. 3 lanes). Similarly, a type IV asymmetric distribution is not as wide as the type III distribution but distributes light further forward for wider roadways (4 lanes) or perimeters of parking lots. A type V distribution produces a symmetric light pattern directly below the luminaire, typically either a round or square pattern of light. For example, positioning LEDs 105 only in three adjacent facets 111 can create a type IV asymmetric distribution of light.

As illustrated in FIG. 2, positioning multiple LEDs 105 in the same facet 111 increases directional intensity of the light relative to the facet 111 (as compared to a facet 111 with only one or no LEDs 105). For example, positioning the LEDs 105 in a linear array 205 along the facet 111 increases directional intensity of the light substantially normal to the axis of the facet 111. Directional intensity also can be adjusted by increasing or decreasing the electric power to one or more of the LEDs 105. For example, overdriving one or more LEDs 105 increases the directional intensity of the light from the LEDs 105 in a direction normal to the corresponding facet 111. Similarly, using LEDs 105 with different sizes and/or wattages can adjust directional intensity. For example, replacing an LED 105 with another LED 105 that has a higher wattage can increase the directional intensity of the light from the LEDs 105 in a direction normal to the corresponding facet 111.

The optical distribution of the light fixture 100 can be adjusted by changing the output direction and/or intensity of one or more of the LEDs 105. In other words, the optical distribution of the light fixture 100 can be adjusted by mounting additional LEDs 105 to the member 110d, removing LEDs 105 from the member 110d, and/or by changing the position and/or configuration of one or more of the LEDs 105. For example, one or more of the LEDs 105 can be repositioned in a different facet 111, repositioned in a different location within the same facet 111, removed from the light fixture 100, or reconfigured to have a different level of electric power. A given light fixture 100 can be adjusted to have any number of optical distributions.

For example, if a particular lighting application only requires light to be emitted towards one direction, LEDs 105 can be placed only on facets 111 corresponding to that direction. If the intensity of the emitted light in that direction is too low, the electric power to the LEDs 105 may be increased, and/or additional LEDs 105 may be added to those facets 111. Similarly, if the intensity of the emitted light in that direction is too high, the electric power to the LEDs 105 may be decreased, and/or one or more of the LEDs 105 may be removed from the facets 111. If the lighting application changes to require a larger beam spread of light in multiple directions, additional LEDs 105 can be placed on empty, adjacent facets 111. In addition, the beam spread may be tightened by moving one or more of the LEDs 105 downward within their respective facets 111, towards the bottom end 110db. Similarly, the beam spread may be broadened by moving one or more of the LEDs 105 upwards within their respective facets 111, towards the top end 110da. Thus, the light fixture 100 provides flexibility in establishing and adjusting optical distribution.

Although illustrated in FIGS. 1 and 2 as having a frustoconical geometry, a person of ordinary skill in the art having the benefit of the present disclosure will recognize that the

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member 110d can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member 110d can have a cylindrical shape. Similarly, although illustrated as having a substantially vertical orientation, each facet 111 may have any orientation, including, but not limited to, a horizontal or angular orientation, in certain alternative exemplary embodiments.

The level of light a typical LED 105 outputs depends, in part, upon the amount of electrical current supplied to the LED 105 and upon the operating temperature of the LED 105. Thus, the intensity of light emitted by an LED 105 changes when electrical current is constant and the LED's 105 temperature varies or when electrical current varies and temperature remains constant, with all other things being equal. Operating temperature also impacts the usable lifetime of most LEDs 105.

As a byproduct of converting electricity into light, LEDs 105 generate a substantial amount of heat that raises the operating temperature of the LEDs 105 if allowed to accumulate on the LEDs 105, resulting in efficiency degradation and premature failure. The member 110d is configured to manage heat output by the LEDs 105. Specifically, the frusto-conical shape of the member 110d creates a venturi effect, drawing air through the channel 110c. The air travels from the bottom end 110db of the member 110d, through the channel 110c, and out the top end 110da. This air movement assists in dissipating heat generated by the LEDs 105. Specifically, the air dissipates the heat away from the member 110d and the LEDs 105 thereon. Thus, the member 110d acts as a heat sink for the LEDs 105 positioned within or along the facets 111.

FIG. 3 is a side elevational view of a light fixture 300 with an optical distribution capable of being adjusted. The light fixture 300 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 300 includes a cover 305. The cover 305 is an optically transmissive element that provides protection from dirt, dust, moisture, and the like. The cover 305 is disposed at least partially around the facets 111, with a top end thereof being coupled to the top surface 110ab of the housing 110. In certain exemplary embodiments, the cover 305 is configured to control light from the LEDs 105 via refraction, diffusion, or the like. For example, the cover 305 can include a refractor, a lens, an optic, or a milky plastic or glass element.

FIG. 4 is a cross-sectional side view of a light fixture 400 with an optical distribution capable of being adjusted, according to another alternative exemplary embodiment. Like the light fixture 300 of FIG. 3, the light fixture 400 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 400 includes a cover 405. The cover 405 includes an optically transmissive element 410 that provides protection from dirt, dust, moisture, and the like. The cover 405 is disposed at least partially around the facets 111, with a top end 405a thereof being attached to a bottom surface 110e of the top end 110a of the housing 110. For example, the top end 405a can be attached to one or more ledges 520 (shown in FIG. 5) extending from the bottom surface 110e of the housing 110. Another end 405b of the cover 405 is attached to the bottom end 110db of the member 110d. In certain exemplary embodiments, there is a sealing element (not shown) between the cover 405 and the member 110d, at one or more points of attachment. In certain exemplary embodiments, the cover 405 is configured to control light from the LEDs 105 via refraction, diffusion, or the like. For example, the cover 405 can include a refractor, a lens, an optic, or a milky plastic or glass element.

FIG. 5 is a perspective view of a light fixture 500 with an optical distribution capable of being adjusted, according to

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yet another alternative exemplary embodiment. The light fixture 500 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 500 includes one or more fins 505 acting as heat sinks for managing heat produced by the LEDs 105. In certain exemplary embodiments, each fin 505 is associated with a facet 111 and includes an elongated member 505a that extends from an interior surface (of the member 110d) opposite its associated facet 111, within the channel 110c, to a core region 505b. A channel 510 extends through the core region 505b, within the channel 110c. The fins 505 are spaced annularly around the channel 510. Alternatively, one or more of the fins 505 can be independent of the facets 111 and can be positioned radially in a symmetrical or non-symmetrical pattern.

Heat transfers from the LEDs 105 via a heat-transfer path extending from the LEDs 105, through the member 110d, and to the fins 505. For example, the heat 105 from a particular LED 105 transfers from the substrate 105a of the LED 105 to its corresponding facet 111, and from the facet 111 through the member 110d to the corresponding fin 505. The fins 505 receive the conducted heat and transfer the conducted heat to the surrounding environment (typically air) via convection.

The channel 510 supports convection-based cooling. For example, as described above in connection with FIGS. 1 and 2, the frusto-conical shape of the member 110d creates a venturi effect, drawing air through the channel 510. The air travels from the bottom end 110b of the housing 110, through the channel 510, and out the top end 110a. This air movement assists in dissipating heat generated by the LEDs 105 away from the LEDs 105. In certain alternative exemplary embodiments, the fins 505 converge within the channel 110c so that there is not an inner channel 510 within the channel 110c. In such an embodiment, the channel 110c supports convection-based cooling substantially as described above.

In the embodiment depicted in FIG. 5, the fins 505 are integral to the member 110d. In certain exemplary embodiments, the fins 505 can be formed on the member 110d via molding, casting, extrusion, or die-based material processing. For example, the member 110d and fins 505 can be comprised of die-cast aluminum. Alternatively, the fins 505 can be mounted or attached to the member 110d by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other fastening means known to a person of ordinary skill in the art having the benefit of the present disclosure. Like the light fixtures 300 and 400 of FIGS. 3 and 4, respectively, in certain alternative exemplary embodiments, the light fixture 500 can be modified to include a cover (not shown).

Although illustrated in FIG. 5 as having a frusto-conical geometry, a person of ordinary skill in the art having the benefit of the present disclosure will recognize that the member 110d can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member 110d can have a cylindrical shape.

Although specific embodiments of the invention have been described above in detail, the description is merely for purposes of illustration. It should be appreciated, therefore, that many aspects of the invention were described above by way of example only and are not intended as required or essential elements of the invention unless explicitly stated otherwise. Various modifications of, and equivalent steps corresponding to, the disclosed aspects of the exemplary embodiments, in addition to those described above, can be made by a person of ordinary skill in the art, having the benefit of this disclosure, without departing from the spirit and scope of the invention defined in the following claims, the scope of which is to be

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accorded the broadest interpretation so as to encompass such modifications and equivalent structures.

What is claimed is:

- 1.** A light fixture, comprising:
a member comprising:
an interior surface of the member;
an exterior surface of the member;
a first aperture disposed along a top end of the member;
a second aperture disposed along a bottom end of the member;
a channel extending from the first aperture to the second aperture and defined by the interior surface;
a plurality of receiving surfaces that are removably coupled to the exterior surface of the member, wherein each receiving surface is configured to receive one or more light emitting diodes (LEDs) that are removably coupled to the respective receiving surface, wherein a position of the one or more LEDs can be changed to modify an optical distribution of the light fixture; and
wherein the channel is configured to permit air to pass therethrough from the second aperture to the first aperture and to transfer heat generated by the one or more LEDs.

2. The light fixture of claim 1, wherein at least one receiving surface of the plurality of receiving surfaces is curved.

3. The light fixture of claim 1, wherein at least one receiving surface of the plurality of receiving surfaces is textured.

4. The light fixture of claim 1, wherein at least one receiving surface of the plurality of receiving surfaces is protruded.

5. The light fixture of claim 1, wherein at least one receiving surface of the plurality of receiving surfaces is recessed.

6. The light fixture of claim 1, wherein at least one receiving surface of the plurality of receiving surfaces is bulbous.

- 7.** A light fixture, comprising:
a member comprising:
an interior surface;
an exterior surface;
a first aperture disposed along a top end of the member;
a second aperture disposed along a bottom end of the member;
a first channel extending from the first aperture to the second aperture and defined by the interior surface; the exterior surface comprising a plurality of receiving surfaces, wherein each receiving surface comprises a plurality of removably coupled light emitting diodes (LEDs); and
a plurality of elongated members coupled to the member, wherein the elongated members extend from the interior surface to a central member disposed within and extending along the first channel and having a shape defining a second channel.

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8. The light fixture of claim 7, wherein air passes through the first channel and the second channel and transfers heat generated by the plurality of LEDs.

9. The light fixture of claim 7, wherein the plurality of LEDs is configured symmetrically in a polar array to generate light having a type V symmetric optical distribution.

10. The light fixture of claim 7, wherein a first LED of the plurality of LEDs is removed from one of the plurality of receiving surfaces to generate light having a first optical distribution.

11. The light fixture of claim 7, wherein a second LED is attached to one of the plurality of receiving surfaces in addition to the plurality of LEDs to generate light having a second optical distribution.

12. The light fixture of claim 7, wherein a position of one of the plurality of LEDs is rearranged to generate light having a third optical distribution.

13. The light fixture of claim 7, wherein an optically transmissive cover is disposed about the first member.

- 14.** A light fixture comprising:
a member comprising:
an exterior surface;
an interior surface;
a first aperture disposed along a top end of the member;
a second aperture disposed along a bottom end of the member, and a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface;
at least one first light emitting diode (LED) coupled to a first facet of the exterior surface; and
at least one second LED coupled to a second facet of the exterior surface, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.

15. The light fixture of claim 14, wherein the first and second LEDs are removably coupled to the exterior surface.

16. The light fixture of claim 14, wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.

17. The light fixture of claim 14, wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member.

18. The light fixture of claim 14, wherein a perimeter of the first aperture is larger than a perimeter of the second aperture.

19. The light fixture of claim 14, wherein an optically transmissive cover is disposed about the first member.

20. The light fixture of claim 14, wherein the first and second LEDs are configured to be moved to change an optical distribution.

* * * * *

EXHIBIT 3



US007874700B2

(12) **United States Patent**
Patrick

(10) **Patent No.:** US 7,874,700 B2
(45) **Date of Patent:** *Jan. 25, 2011

(54) **HEAT MANAGEMENT FOR A LIGHT FIXTURE WITH AN ADJUSTABLE OPTICAL DISTRIBUTION**

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(73) Assignee: **Cooper Technologies Company**, Houston, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 262 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/183,490**

(22) Filed: **Jul. 31, 2008**

(65) **Prior Publication Data**

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Related U.S. Application Data

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(51) **Int. Cl.**

F21S 4/00 (2006.01)

F21V 21/00 (2006.01)

F21V 29/00 (2006.01)

F21V 29/02 (2006.01)

(52) **U.S. Cl.** **362/249.02**; 362/218; 362/294; 362/373

(58) **Field of Classification Search** 362/218, 362/294, 373, 249.02

See application file for complete search history.

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Primary Examiner—Sandra L O Shea

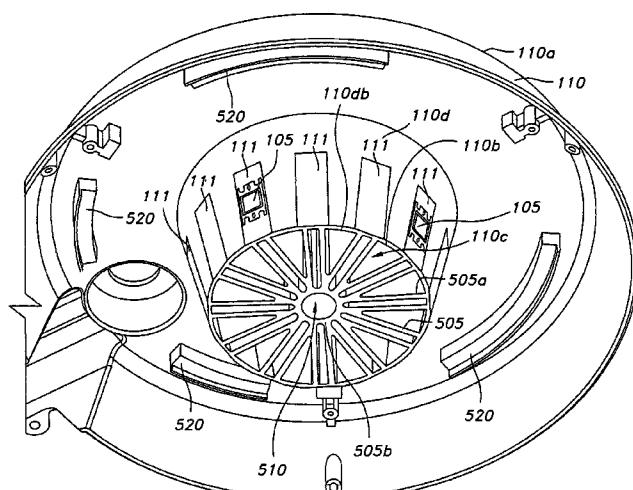
Assistant Examiner—James W Cranson

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(57) **ABSTRACT**

A light fixture includes a member having a substantially frusto-conical shape. A channel extends between a wide top end of the member and a narrower bottom end of the member. The member includes multiple surfaces (“facets”) disposed around its outer surface. Each facet is configured to receive one or more light emitting diodes (“LEDs”) in a linear or non-linear array. Each facet can be integral to the member or coupled to the member. The channel is configured to transfer heat generated by the LEDs through convection. Fins can be disposed within the channel, extending from the inner surface of the member to an inner channel. The fins are configured to transfer heat away from, and provide a greater surface area for convecting heat away from, the member. For example, one or both of the channels can transfer heat by a venturi effect.

25 Claims, 5 Drawing Sheets



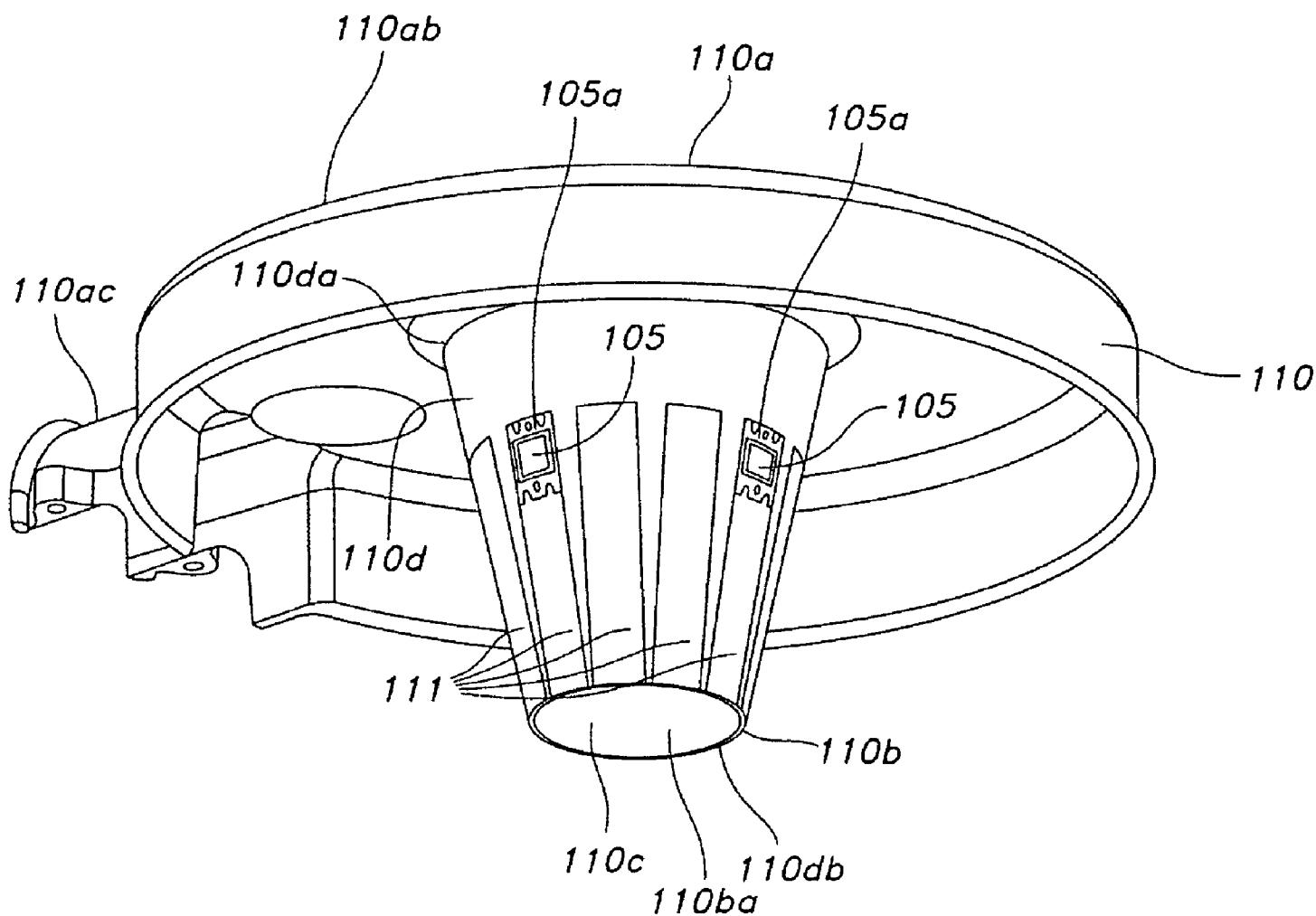


FIG. 1

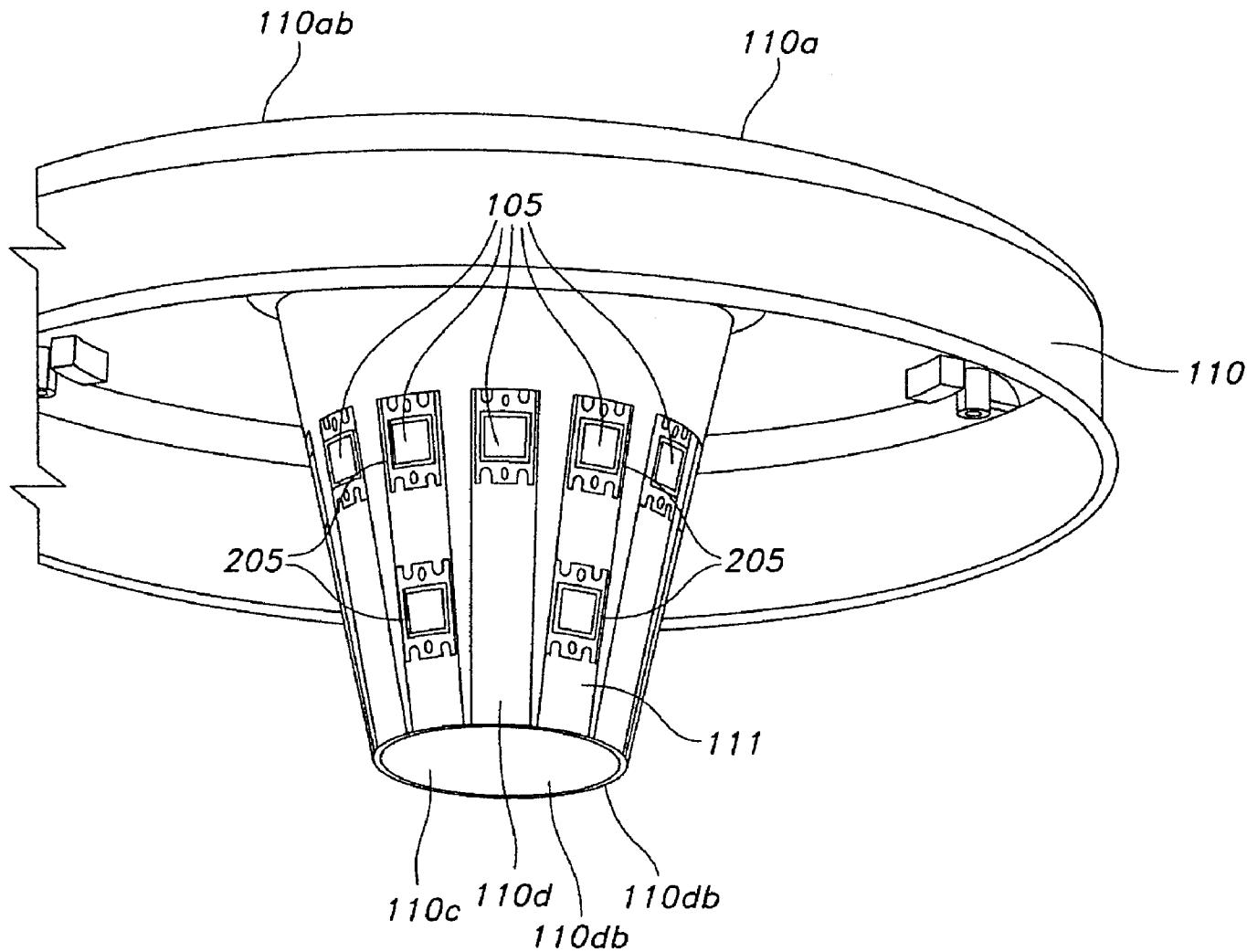


FIG. 2

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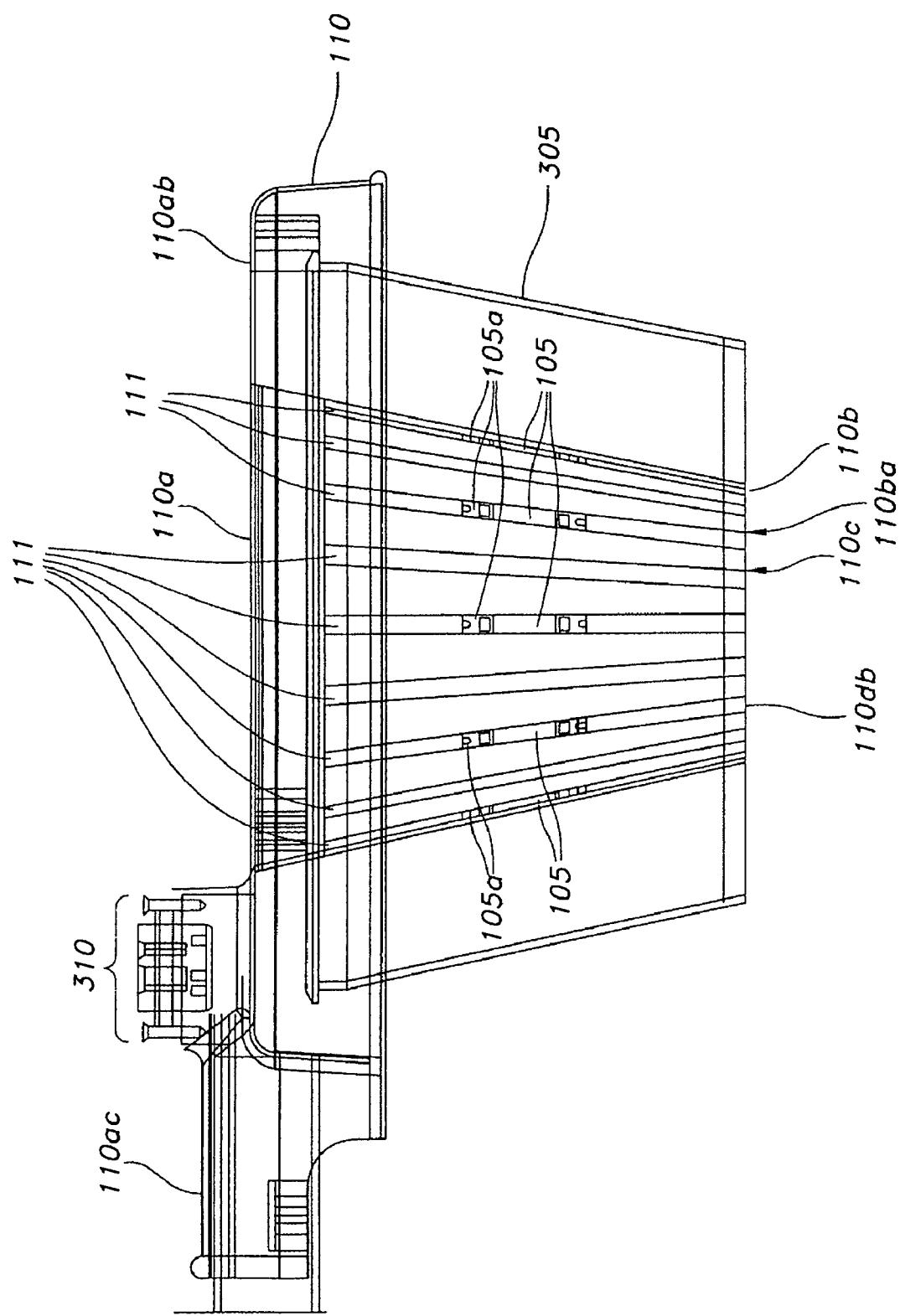


FIG. 3

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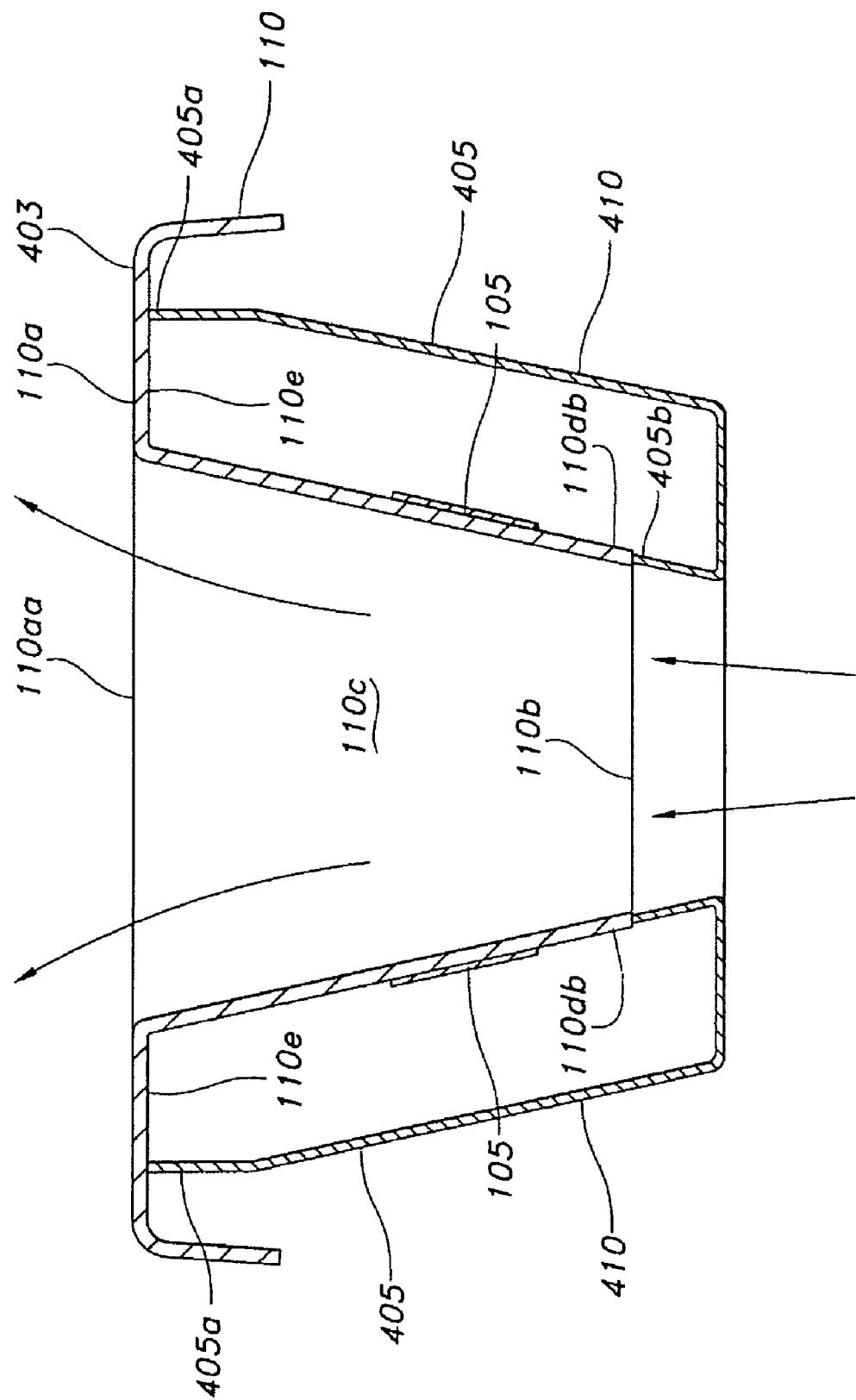


FIG. 4

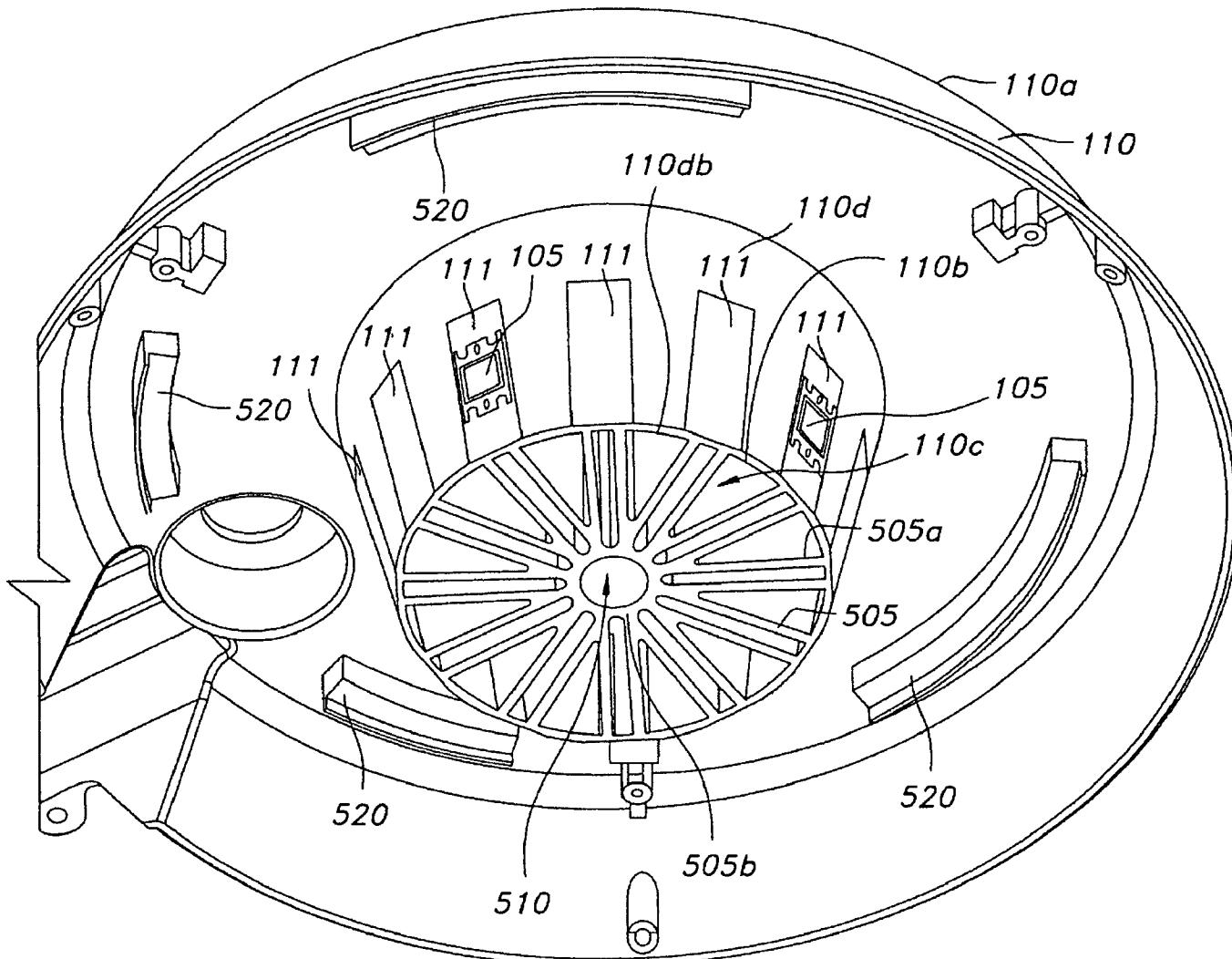


FIG. 5

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**HEAT MANAGEMENT FOR A LIGHT
FIXTURE WITH AN ADJUSTABLE OPTICAL
DISTRIBUTION**

RELATED APPLICATION

This patent application claims priority under 35 U.S.C. §119 to U.S. Provisional Patent Application No. 60/994,371, titled “Flexible Light Emitting Diode Optical Distribution,” filed Sep. 19, 2007. In addition, this patent application is related to U.S. patent application Ser. No. 12/183,499, titled “Light Fixture With An Adjustable Optical Distribution,” filed Jul. 31, 2008. The complete disclosure of each of the foregoing priority and related applications is hereby fully incorporated herein by reference.

TECHNICAL FIELD

The invention relates generally to light fixtures and more particularly to light fixtures with adjustable optical distributions.

BACKGROUND

A luminaire is a system for producing, controlling, and/or distributing light for illumination. For example, a luminaire includes a system that outputs or distributes light into an environment, thereby allowing certain items in that environment to be visible. Luminaires are used in indoor or outdoor applications.

A typical luminaire includes one or more light emitting elements, one or more sockets, connectors, or surfaces configured to position and connect the light emitting elements to a power supply, an optical device configured to distribute light from the light emitting elements, and mechanical components for supporting or suspending the luminaire. Luminaires are sometimes referred to as “lighting fixtures” or as “light fixtures.” A light fixture that has a socket, connector, or surface configured to receive a light emitting element, but no light emitting element installed therein, is still considered a luminaire. That is, a light fixture lacking some provision for full operability may still fit the definition of a luminaire. The term “light emitting element” is used herein to refer to any device configured to emit light, such as a lamp or a light-emitting diode (“LED”).

Optical devices are configured to direct light energy emitted by light emitting elements into one or more desired areas. For example, optical devices may direct light energy through reflection, diffusion, baffling, refraction, or transmission through a lens. Lamp placement within the light fixture also plays a significant role in determining light distribution. For example, a horizontal lamp orientation typically produces asymmetric light distribution patterns, and a vertical lamp orientation typically produces a symmetric light distribution pattern.

Different lighting applications require different optical distributions. For example, a lighting application in a large, open environment may require a symmetric, square distribution that produces a wide, symmetrical pattern of uniform light. Another lighting application in a smaller or narrower environment may require a non-square distribution that produces a focused pattern of light. For example, the amount and direction of light required from a light fixture used on a street pole depends on the location of the pole and the intended environment to be illuminated.

Traditional light fixtures are configured to only output light in a single, predetermined distribution. To change an optical

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distribution in a given environment, a person must uninstall an existing light fixture and install a new light fixture with a different optical configuration. These steps are cumbersome, time consuming, and expensive.

Therefore, a need exists in the art for an improved means for adjusting optical distribution of a light fixture. In particular, a need exists in the art for efficient, user-friendly, and cost-effective systems and methods for adjusting light emitting diode optical distribution of a light fixture.

SUMMARY

The invention provides an improved means for adjusting optical distribution of a light fixture. In particular, the invention provides a light fixture with an adjustable optical distribution. The light fixture can be used in indoor and/or outdoor applications.

The light fixture includes a member having multiple surfaces disposed at least partially around a channel extending through the member. The member can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member can have a frusto-conical or cylindrical shape.

Each surface is configured to receive at least one LED. For example, each surface can receive one or more LEDs in a linear or non-linear array. Each surface can be integral to the member or coupled thereto. For example, the surfaces can be formed on the member via molding, casting, extrusion, or die-based material processing. Alternatively, the surfaces can be mounted or attached to the member by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other fastening means.

Each LED can be removably coupled to a respective one of the surfaces. For example, each LED can be mounted to its respective surface via a substrate that includes one or more sheets of ceramic, metal, laminate, or another material. The optical distribution of the light fixture can be adjusted by changing the output direction and/or intensity of one or more of the LEDs. In other words, the optical distribution of the light fixture can be adjusted by mounting additional LEDs to certain surfaces, removing LEDs from certain surfaces, and/or by changing the position and/or configuration of one or more of the LEDs across the surfaces or along particular surfaces. For example, one or more of the LEDs can be repositioned along a different surface, repositioned in a different location along the same surface, removed from the member, or reconfigured to have a different level of electric power to adjust the optical distribution of the light fixture. A given light fixture can be adjusted to have any number of optical distributions. Thus, the light fixture provides flexibility in establishing and adjusting optical distribution.

As a byproduct of converting electricity into light, LEDs generate a substantial amount of heat. The member can be configured to manage heat output by the LEDs. Specifically, the channel extending through the member is configured to transfer the heat output from the LEDs by convection. Heat from the LEDs is transferred to the surfaces by conduction and to the channel, which convects the heat away. For example, the channel can transfer heat by the venturi effect.

The shape of the channel can correspond to the shape of the member. For example, if the member has a frusto-conical shape, the channel can have a wide top end and a narrower bottom end. Alternatively, the shape of the channel can be independent of the shape of the member.

Fins can be disposed within the channel to assist with the heat transfer. For example, the fins can extend from the surfaces into the channel, towards a core region of the member.

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The core region can include a point where the fins converge. In addition, or in the alternative, the core region can include a member disposed within and extending along the channel and having a shape defining a second, inner channel that extends through the member. The fins can be configured to transfer heat by conduction from the facets to the inner channel. Like the outer channel, the inner channel can be configured to transfer at least a portion of that heat through convection. This air movement assists in dissipating heat generated by the LEDs.

These and other aspects, features and embodiments of the invention will become apparent to a person of ordinary skill in the art upon consideration of the following detailed description of illustrated embodiments exemplifying the best mode for carrying out the invention as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description, in conjunction with the accompanying figures briefly described as follows.

FIG. 1 is a perspective view of a light fixture with an optical distribution capable of being adjusted, according to certain exemplary embodiments.

FIG. 2 is another perspective view of the exemplary light fixture of FIG. 1, wherein the light fixture has a different optical distribution than that illustrated in FIG. 1.

FIG. 3 is a side elevational view of a light fixture with an optical distribution capable of being adjusted, according to certain alternative exemplary embodiments.

FIG. 4 is a cross-sectional side view of a light fixture with an optical distribution capable of being adjusted, according to another alternative exemplary embodiment.

FIG. 5 is a perspective view of a light fixture with an optical distribution capable of being adjusted, according to yet another alternative exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The present invention is directed to systems for adjusting optical distribution of a light fixture. In particular, the invention provides efficient, user-friendly, and cost-effective systems for adjusting optical distribution of a light fixture. The term "optical distribution" is used herein to refer to the spatial or geographic dispersion of light within an environment, including a relative intensity of the light within one or more regions of the environment.

Turning now to the drawings, in which like numerals indicate like elements throughout the figures, exemplary embodiments of the invention are described in detail. FIG. 1 is a perspective view of a light fixture 100 with an optical distribution capable of being adjusted, according to certain exemplary embodiments. FIG. 2 is another perspective view of the light fixture 100, wherein the light fixture 100 has a different optical distribution than that illustrated in FIG. 1. With reference to FIGS. 1 and 2, the light fixture 100 is an electrical device configured to create artificial light or illumination in an indoor and/or outdoor environment. For example, the light fixture 100 is suited for mounting to a pole (not shown) or similar structure, for use as a street light.

In the exemplary embodiments depicted in FIGS. 1 and 2, the light fixture 100 is configured to create artificial light or illumination via one or more LEDs 105. Each LED 105 is mounted to an outer surface 111 of a housing 110. The housing 110 includes a top end 110a and a bottom end 110b. Each

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end 110a and 110b includes an aperture 110aa (FIG. 4) and 110ba, respectively. A channel 110c extends through the housing 110 and connects the apertures 110aa and 110ba. The top end 110a includes a substantially round top surface 110ab disposed around the channel 110c. A mounting member 110ac extends outward from the top surface 110ab, in a direction away from the channel 110c. The mounting member 110ac is configured to be coupled to the pole, for mounting the light fixture 100 thereto.

10 In certain exemplary embodiments, a light-sensitive photocell 310 is coupled to the mounting member 110ac. The photocell 310 is configured to change electrical resistance in a circuit that includes one or more of the LEDs 105, based on incident light intensity. For example, the photocell 310 can cause the LEDs 105 to output light at dusk but not to output light at dawn.

A member 110d extends downward from the top surface 110ab, around the channel 110c. The member 110d has a frusto-conical geometry, with a top end 110da and a bottom end 110db that has a diameter that is less than a diameter of the top end 110da. Each outer surface 111 includes a substantially flat, curved, angular, textured, recessed, protruding, bulbous, and/or other-shaped surface disposed along an outer perimeter of the member 110d. For simplicity, each outer surface 111 is referred to herein as a "facet." The LEDs 105 can be mounted to the facets 111 by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other means known to a person of ordinary skill in the art having the benefit of the present disclosure.

20 In the exemplary embodiments depicted in FIGS. 1 and 2, the housing 110 includes twenty facets 111. The number of facets 111 can vary depending on the size of the LEDs 105, the size of the housing 110, cost considerations, and other financial, operational, and/or environmental factors known to a person of ordinary skill in the art having the benefit of the present disclosure. As will be readily apparent to a person of ordinary skill in the art, a larger number of facets 111 corresponds to a higher level of flexibility in adjusting the optical distribution of the light fixture 100. In particular, as described below, each facet 111 is configured to receive one or more LEDs 105 in one or more positions. The greater the number of facets 111 present on the member 110d, the greater the number of LED 105 positions, and thus optical distributions, available.

30 In the embodiments depicted in FIGS. 1 and 2, the end 110a and member 110d are integral to the housing 110, and the facets 111 are integral to the member 110d. In certain exemplary embodiments, the housing 110 and/or the end 110a, member 110d, and/or facets 111 thereof can be formed via molding, casting, extrusion, or die-based material processing. For example, the housing 110 and facets 111 can be comprised of die-cast aluminum. In certain alternative exemplary embodiments, the end 110a, member 110d, and/or facets 111 include separate components coupled together to form the housing 110. For example, the facets 111 can be mounted or attached to the member 110d by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other attachment means known to a person of ordinary skill in the art having the benefit of the present disclosure.

40 Each facet 111 is configured to receive a column of one or more LEDs 105. The term "column" is used herein to refer to an arrangement or a configuration whereby one or more LEDs 105 are disposed approximately in or along a line. 45 LEDs 105 in a column are not necessarily in perfect alignment with one another. For example, one or more LEDs 105 in a column might be slightly out of perfect alignment due to

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manufacturing tolerances or assembly deviations. In addition, LEDs **105** in a column might be purposely staggered in a non-linear arrangement. Each column extends along an axis of its associated facet **111**.

In certain exemplary embodiments, each LED **105** is mounted to its corresponding facet **111** via a substrate **105a**. Each substrate **105a** includes one or more sheets of ceramic, metal, laminate, or another material. Each LED **105** is attached to its respective substrate **105a** by a solder joint, a plug, an epoxy or bonding line, or another suitable provision for mounting an electrical/optical device on a surface. Each substrate **105a** is connected to support circuitry (not shown) or a driver (not shown) for supplying electrical power and control to the associated LED **105**. The support circuitry (not shown) includes one or more transistors, operational amplifiers, resistors, controllers, digital logic elements, or the like for controlling and powering the LED **105**.

In certain exemplary embodiments, the LEDs **105** include semiconductor diodes configured to emit incoherent light when electrically biased in a forward direction of a p-n junction. For example, each LED **105** can emit blue or ultraviolet light. The emitted light can excite a phosphor that in turn emits red-shifted light. The LEDs **105** and the phosphors can collectively emit blue and red-shifted light that essentially matches blackbody radiation. The emitted light approximates or emulates incandescent light to a human observer. In certain exemplary embodiments, the LEDs **105** and their associated phosphors emit substantially white light that may seem slightly blue, green, red, yellow, orange, or some other color or tint. Exemplary embodiments of the LEDs **105** can include indium gallium nitride (“InGaN”) or gallium nitride (“GaN”) for emitting blue light.

In certain exemplary embodiments, one or more of the LEDs **105** includes multiple LED elements (not shown) mounted together on a single substrate **105a**. Each of the LED elements can produce the same or a distinct color of light. The LED elements can collectively produce substantially white light or light emulating a blackbody radiator. In certain exemplary embodiments, some of the LEDs **105** produce one color of light while others produce another color of light. Thus, in certain exemplary embodiments, the LEDs **105** provide a spatial gradient of colors.

In certain exemplary embodiments, optically transparent or clear material (not shown) encapsulates each LED **105** and/or LED element, either individually or collectively. This material provides environmental protection while transmitting light. For example, this material can include a conformal coating, a silicone gel, cured/curable polymer, adhesive, or some other material known to a person of ordinary skill in the art having the benefit of the present disclosure. In certain exemplary embodiments, phosphors configured to convert blue light to light of another color are coated onto or dispersed in the encapsulating material.

The optical distribution of the light fixture **100** depends on the positioning and configuration of the LEDs **105** within the facets **111**. For example, as illustrated in FIG. 1 and FIG. 3, described below, positioning multiple LEDs **105** symmetrically along the outer perimeter of the member **110d**, in a polar array, can create a type V symmetric distribution of light. Outdoor area and roadway luminaires are designed to distribute light over different areas, classified with designations I, II, III, IV, and V. Generally, type II distributions are wide, asymmetric light patterns used to light narrow roadways (i.e. 2 lanes) from the edge of the roadway. Type III asymmetric distributions are not quite as wide as type II distributions but throw light further forward for wider roadways (i.e. 3 lanes). Similarly, a type IV asymmetric distribution is not as wide as

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the type III distribution but distributes light further forward for wider roadways (4 lanes) or perimeters of parking lots. A type V distribution produces a symmetric light pattern directly below the luminaire, typically either a round or square pattern of light. For example, positioning LEDs **105** only in three adjacent facets **111** can create a type IV asymmetric distribution of light.

As illustrated in FIG. 2, positioning multiple LEDs **105** in the same facet **111** increases directional intensity of the light relative to the facet **111** (as compared to a facet **111** with only one or no LEDs **105**). For example, positioning the LEDs **105** in a linear array **205** along the facet **111** increases directional intensity of the light substantially normal to the axis of the facet **111**. Directional intensity also can be adjusted by increasing or decreasing the electric power to one or more of the LEDs **105**. For example, overdriving one or more LEDs **105** increases the directional intensity of the light from the LEDs **105** in a direction normal to the corresponding facet **111**. Similarly, using LEDs **105** with different sizes and/or wattages can adjust directional intensity. For example, replacing an LED **105** with another LED **105** that has a higher wattage can increase the directional intensity of the light from the LEDs **105** in a direction normal to the corresponding facet **111**.

The optical distribution of the light fixture **100** can be adjusted by changing the output direction and/or intensity of one or more of the LEDs **105**. In other words, the optical distribution of the light fixture **100** can be adjusted by mounting additional LEDs **105** to the member **110d**, removing LEDs **105** from the member **110d**, and/or by changing the position and/or configuration of one or more of the LEDs **105**. For example, one or more of the LEDs **105** can be repositioned in a different facet **111**, repositioned in a different location within the same facet **111**, removed from the light fixture **100**, or reconfigured to have a different level of electric power. A given light fixture **100** can be adjusted to have any number of optical distributions.

For example, if a particular lighting application only requires light to be emitted towards one direction, LEDs **105** can be placed only on facets **111** corresponding to that direction. If the intensity of the emitted light in that direction is too low, the electric power to the LEDs **105** may be increased, and/or additional LEDs **105** may be added to those facets **111**. Similarly, if the intensity of the emitted light in that direction is too high, the electric power to the LEDs **105** may be decreased, and/or one or more of the LEDs **105** may be removed from the facets **111**. If the lighting application changes to require a larger beam spread of light in multiple directions, additional LEDs **105** can be placed on empty, adjacent facets **111**. In addition, the beam spread may be tightened by moving one or more of the LEDs **105** downward within their respective facets **111**, towards the bottom end **110db**. Similarly, the beam spread may be broadened by moving one or more of the LEDs **105** upwards within their respective facets **111**, towards the top end **110da**. Thus, the light fixture **100** provides flexibility in establishing and adjusting optical distribution.

Although illustrated in FIGS. 1 and 2 as having a frustoconical geometry, a person of ordinary skill in the art having the benefit of the present disclosure will recognize that the member **110d** can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member **110d** can have a cylindrical shape. Similarly, although illustrated as having a substantially vertical orientation, each facet **111** may have any orientation, including, but not limited to, a horizontal or angular orientation, in certain alternative exemplary embodiments.

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The level of light a typical LED 105 outputs depends, in part, upon the amount of electrical current supplied to the LED 105 and upon the operating temperature of the LED 105. Thus, the intensity of light emitted by an LED 105 changes when electrical current is constant and the LED's 105 temperature varies or when electrical current varies and temperature remains constant, with all other things being equal. Operating temperature also impacts the usable lifetime of most LEDs 105.

As a byproduct of converting electricity into light, LEDs 105 generate a substantial amount of heat that raises the operating temperature of the LEDs 105 if allowed to accumulate on the LEDs 105, resulting in efficiency degradation and premature failure. The member 110d is configured to manage heat output by the LEDs 105. Specifically, the frusto-conical shape of the member 110d creates a venturi effect, drawing air through the channel 110c. The air travels from the bottom end 110db of the member 110d, through the channel 110c, and out the top end 110da. This air movement assists in dissipating heat generated by the LEDs 105. Specifically, the air dissipates the heat away from the member 110d and the LEDs 105 thereon. Thus, the member 110d acts as a heat sink for the LEDs 105 positioned within or along the facets 111.

FIG. 3 is a side elevational view of a light fixture 300 with an optical distribution capable of being adjusted. The light fixture 300 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 300 includes a cover 305. The cover 305 is an optically transmissive element that provides protection from dirt, dust, moisture, and the like. The cover 305 is disposed at least partially around the facets 111, with a top end thereof being coupled to the top surface 110ab of the housing 110. In certain exemplary embodiments, the cover 305 is configured to control light from the LEDs 105 via refraction, diffusion, or the like. For example, the cover 305 can include a refractor, a lens, an optic, or a milky plastic or glass element.

FIG. 4 is a cross-sectional side view of a light fixture 400 with an optical distribution capable of being adjusted, according to another alternative exemplary embodiment. Like the light fixture 300 of FIG. 3, the light fixture 400 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 400 includes a cover 405. The cover 405 includes an optically transmissive element 410 that provides protection from dirt, dust, moisture, and the like. The cover 405 is disposed at least partially around the facets 111, with a top end 405a thereof being attached to a bottom surface 110e of the top end 110a of the housing 110. For example, the top end 405a can be attached to one or more ledges 520 (shown in FIG. 5) extending from the bottom surface 110e of the housing 110. Another end 405b of the cover 405 is attached to the bottom end 110db of the member 110d. In certain exemplary embodiments, there is a sealing element (not shown) between the cover 405 and the member 110d, at one or more points of attachment. In certain exemplary embodiments, the cover 405 is configured to control light from the LEDs 105 via refraction, diffusion, or the like. For example, the cover 405 can include a refractor, a lens, an optic, or a milky plastic or glass element.

FIG. 5 is a perspective view of a light fixture 500 with an optical distribution capable of being adjusted, according to yet another alternative exemplary embodiment. The light fixture 500 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 500 includes one or more fins 505 acting as heat sinks for managing heat produced by the LEDs 105. In certain exemplary embodiments, each fin 505 is associated with a facet 111 and includes an elongated member 505a that extends from an interior surface (of the member

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110d) opposite its associated facet 111, within the channel 110c, to a core region 505b. A channel 510 extends through the core region 505b, within the channel 110c. The fins 505 are spaced annularly around the channel 510. Alternatively, one or more of the fins 505 can be independent of the facets 111 and can be positioned radially in a symmetrical or non-symmetrical pattern.

Heat transfers from the LEDs 105 via a heat-transfer path extending from the LEDs 105, through the member 110d, and to the fins 505. For example, the heat 105 from a particular LED 105 transfers from the substrate 105a of the LED 105 to its corresponding facet 111, and from the facet 111 through the member 110d to the corresponding fin 505. The fins 505 receive the conducted heat and transfer the conducted heat to the surrounding environment (typically air) via convection.

The channel 510 supports convection-based cooling. For example, as described above in connection with FIGS. 1 and 2, the frusto-conical shape of the member 110d creates a venturi effect, drawing air through the channel 510. The air travels from the bottom end 110b of the housing 110, through the channel 510, and out the top end 110a. This air movement assists in dissipating heat generated by the LEDs 105 away from the LEDs 105. In certain alternative exemplary embodiments, the fins 505 converge within the channel 110c so that there is not an inner channel 510 within the channel 110c. In such an embodiment, the channel 110c supports convection-based cooling substantially as described above.

In the embodiment depicted in FIG. 5, the fins 505 are integral to the member 110d. In certain exemplary embodiments, the fins 505 can be formed on the member 110d via molding, casting, extrusion, or die-based material processing. For example, the member 110d and fins 505 can be comprised of die-cast aluminum. Alternatively, the fins 505 can be mounted or attached to the member 110d by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other fastening means known to a person of ordinary skill in the art having the benefit of the present disclosure. Like the light fixtures 300 and 400 of FIGS. 3 and 4, respectively, in certain alternative exemplary embodiments, the light fixture 500 can be modified to include a cover (not shown).

Although illustrated in FIG. 5 as having a frusto-conical geometry, a person of ordinary skill in the art having the benefit of the present disclosure will recognize that the member 110d can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member 110d can have a cylindrical shape.

Although specific embodiments of the invention have been described above in detail, the description is merely for purposes of illustration. It should be appreciated, therefore, that many aspects of the invention were described above by way of example only and are not intended as required or essential elements of the invention unless explicitly stated otherwise. Various modifications of, and equivalent steps corresponding to, the disclosed aspects of the exemplary embodiments, in addition to those described above, can be made by a person of ordinary skill in the art, having the benefit of this disclosure, without departing from the spirit and scope of the invention defined in the following claims, the scope of which is to be accorded the broadest interpretation so as to encompass such modifications and equivalent structures.

What is claimed is:

1. A light fixture, comprising:
a member comprising:
a first surface disposed along an interior of the member;
a second surface disposed along an exterior of the member;

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a first end comprising a first aperture;
 a second end comprising a second aperture;
 a channel extending from the first aperture to the second
 aperture and defined by the first surface; and
 a plurality of receiving surfaces disposed at least par-
 tially around the channel, along the second surface of
 the member, each receiving surface being configured
 to receive at least one light emitting diode; and
 at least one light emitting diode, each light emitting diode
 being removably coupled to a respective one of the
 receiving surfaces,

wherein the light emitting diodes transfer heat through
 conduction to the member; and
 wherein air passes through the channel to transfer heat
 from member.

2. The light fixture of claim 1, wherein the heat is trans-
 ferred from the member through the channel by convection.

3. The light fixture of claim 1, wherein the channel is
 configured to transfer the heat from the member by a venturi
 effect.

4. The light fixture of claim 1, wherein the first aperture is
 disposed along a top end, and the second aperture is disposed
 along a bottom end, and wherein the second aperture is nar-
 rower than the first aperture.

5. The light fixture of claim 1, further comprising a plural-
 ity of elongated members, each elongated member coupled
 along one end to the first surface and disposed at least par-
 tially within the channel.

6. The light fixture of claim 5, wherein each elongated
 member extends from the first surface opposite a correspond-
 ing one of the receiving surfaces on the second surface.

7. The light fixture of claim 5, wherein a pair of elongated
 members extend from the first surface opposite a correspond-
 ing one of the receiving surfaces on the second surface.

8. The light fixture of claim 5, wherein the elongated mem-
 bers are positioned symmetrically within the channel.

9. The light fixture of claim 5, wherein each elongated
 member transfers heat from its corresponding receiving sur-
 face to the channel.

10. The light fixture of claim 5, wherein each elongated
 member transfers heat from the first surface to the channel.

11. The light fixture of claim 5, wherein the elongated
 members converge at a point within the channel.

12. The light fixture of claim 5, wherein the elongated
 members converge at a central member disposed within and
 extending along the channel and having a shape defining a
 second channel.

13. The light fixture of claim 1, wherein each light emitting
 diode is removably coupled to its respective receiving surface
 via a substrate that is in thermal contact with the receiving
 surface.

14. The light fixture of claim 1, wherein the member has a
 substantially frusto-conical shape.

15. The light fixture of claim 1, wherein the member has a
 substantially cylindrical shape.

16. A light fixture, comprising:
 a member comprising:
 an interior surface;
 an exterior surface;
 a first aperture disposed along a top end;
 second aperture disposed along a second end;
 a channel extending from the first aperture to the second
 aperture and defined by the interior surface; and
 a plurality of receiving surfaces disposed at least par-
 tially along the exterior surface, each receiving sur-
 face configured to receive at least one light emitting
 diode; and

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at least one light emitting diode, each light emitting diode
 being removably coupled to a respective one of the
 receiving surfaces,

wherein the channel transfers at least a portion of heat
 generated by the light emitting diode through the first
 aperture.

17. The light fixture of claim 16, wherein the heat is trans-
 ferred from the member through the channel by convection.

18. The light fixture of claim 16, wherein the heat is trans-
 ferred from the member through the channel by a venturi
 effect.

19. The light fixture of claim 16, further comprising a
 plurality of elongated members, each elongated member
 coupled along one end to the interior surface and disposed at
 least partially within the channel.

20. The light fixture of claim 19, wherein each elongated
 member extends from the interior surface opposite a corre-
 sponding one of the receiving surfaces on the exterior surface.

21. The light fixture of claim 16, wherein each light emit-
 ting diode is removably coupled to its corresponding receiv-
 ing surface via a substrate that is in thermal contact with the
 receiving surface.

22. A light fixture, comprising:

a member comprising:
 an interior surface;
 an exterior surface;
 a first aperture disposed along a top end;
 a second aperture disposed along a second end;
 a first channel extending from the first aperture to the
 second aperture and defined by the interior surface;
 and
 a plurality of substantially longitudinal receiving sur-
 faces disposed at least partially around the first chan-
 nel, along the exterior surface, each receiving surface
 being configured to receive at least one light emitting
 diode; and

a plurality of elongated members disposed at least par-
 tially within the first channel, each elongated member
 extending from the inner surface opposite a corre-
 sponding one of the receiving surfaces, to a central
 member disposed within and extending along the first
 channel and having a shape defining a second chan-
 nel, the second channel disposed within the first chan-
 nel; and

at least one light emitting diode, each light emitting diode
 removably coupled to a respective one of the receiving
 surfaces,

wherein each elongated member conducts heat from its
 corresponding receiving surface.

23. The light fixture of claim 22, wherein the central mem-
 ber is configured to:

conduct the heat from the elongated members; and
 transfer at least a portion of the received heat through the
 second channel by convection.

24. The light fixture of claim 22, wherein each light emit-
 ting diode is removably coupled to its respective receiving
 surface via a substrate that is in thermal contact with the
 receiving surface.

25. The light fixture of claim 24, wherein each receiving
 surface is configured to transfer heat from the substrate to at
 least one of the elongated members.

EXHIBIT 4



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(12) **United States Patent**
Patrick

(10) **Patent No.:** US 8,939,608 B1
(45) **Date of Patent:** Jan. 27, 2015

(54) **HEAT MANAGEMENT FOR A LIGHT FIXTURE WITH AN ADJUSTABLE OPTICAL DISTRIBUTION**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 186 days.

(21) Appl. No.: **13/600,790**

(22) Filed: **Aug. 31, 2012**

Related U.S. Application Data

(63) Continuation of application No. 12/961,315, filed on Dec. 6, 2010, now Pat. No. 8,256,923, which is a continuation of application No. 12/183,490, filed on Jul. 31, 2008, now Pat. No. 7,874,700.

(60) Provisional application No. 60/994,371, filed on Sep. 19, 2007.

(51) **Int. Cl.**
F21S 4/00 (2006.01)

(52) **U.S. Cl.**
USPC **362/249.02; 362/231**

(58) **Field of Classification Search**
USPC **362/249.02, 545, 226, 231, 247, 800**
See application file for complete search history.

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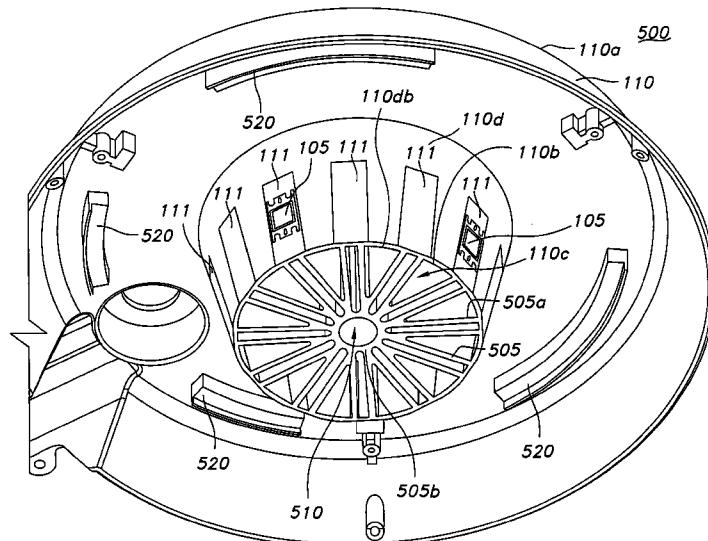
Primary Examiner — Anne Hines

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(57) **ABSTRACT**

A light fixture includes a member having a substantially frusto-conical shape. A channel extends between a wide top end of the member and a narrower bottom end of the member. The member includes multiple surfaces (“facets”) disposed around its outer surface. Each facet is configured to receive one or more light emitting diodes (“LEDs”) in a linear or non-linear array. Each facet can be integral to the member or coupled to the member. The channel is configured to transfer heat generated by the LEDs through convection. Fins can be disposed within the channel, extending from the inner surface of the member to an inner channel. The fins are configured to transfer heat away from, and provide a greater surface area for convecting heat away from, the member. For example, one or both of the channels can transfer heat by a venturi effect.

18 Claims, 5 Drawing Sheets



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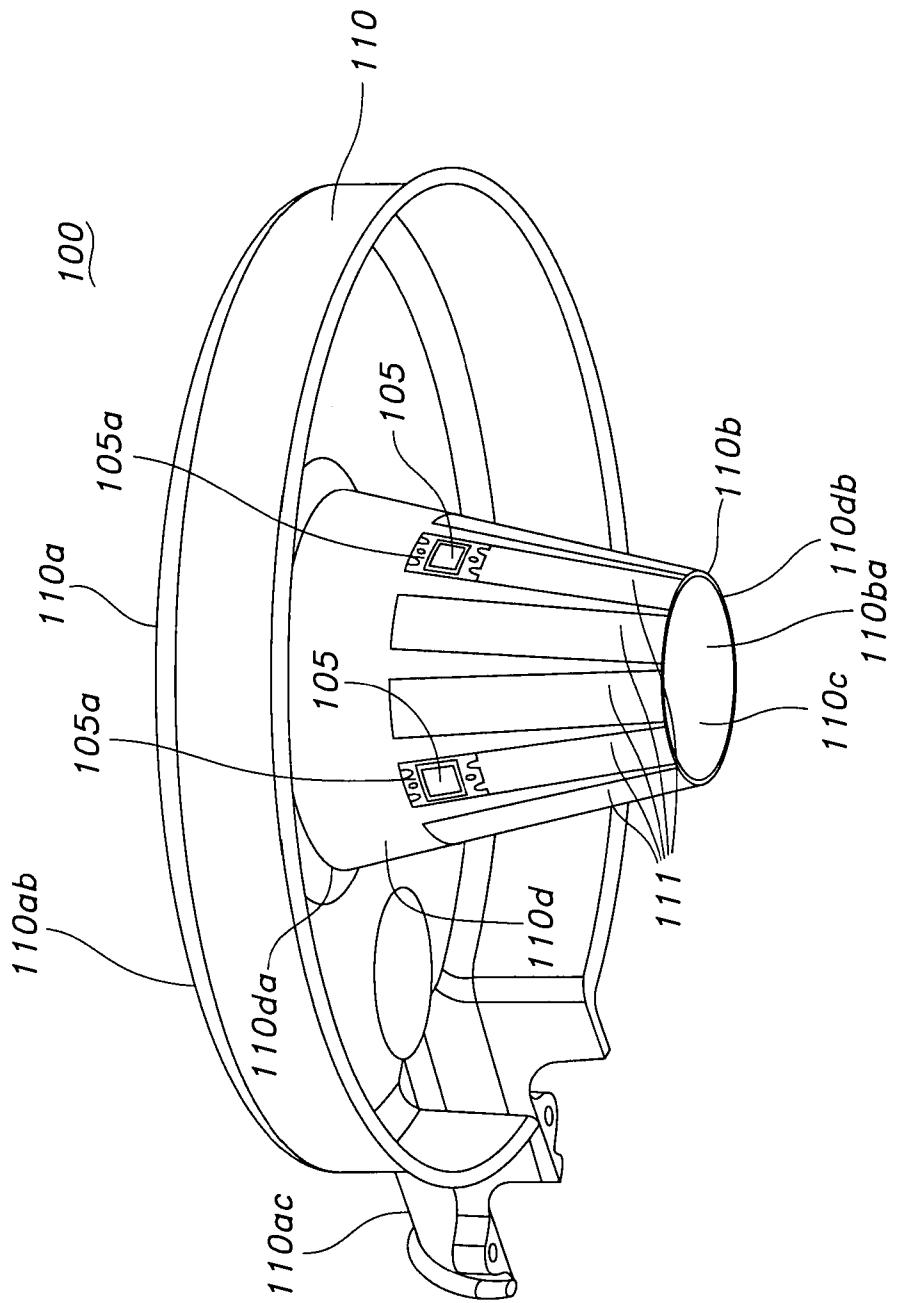


FIG. 1

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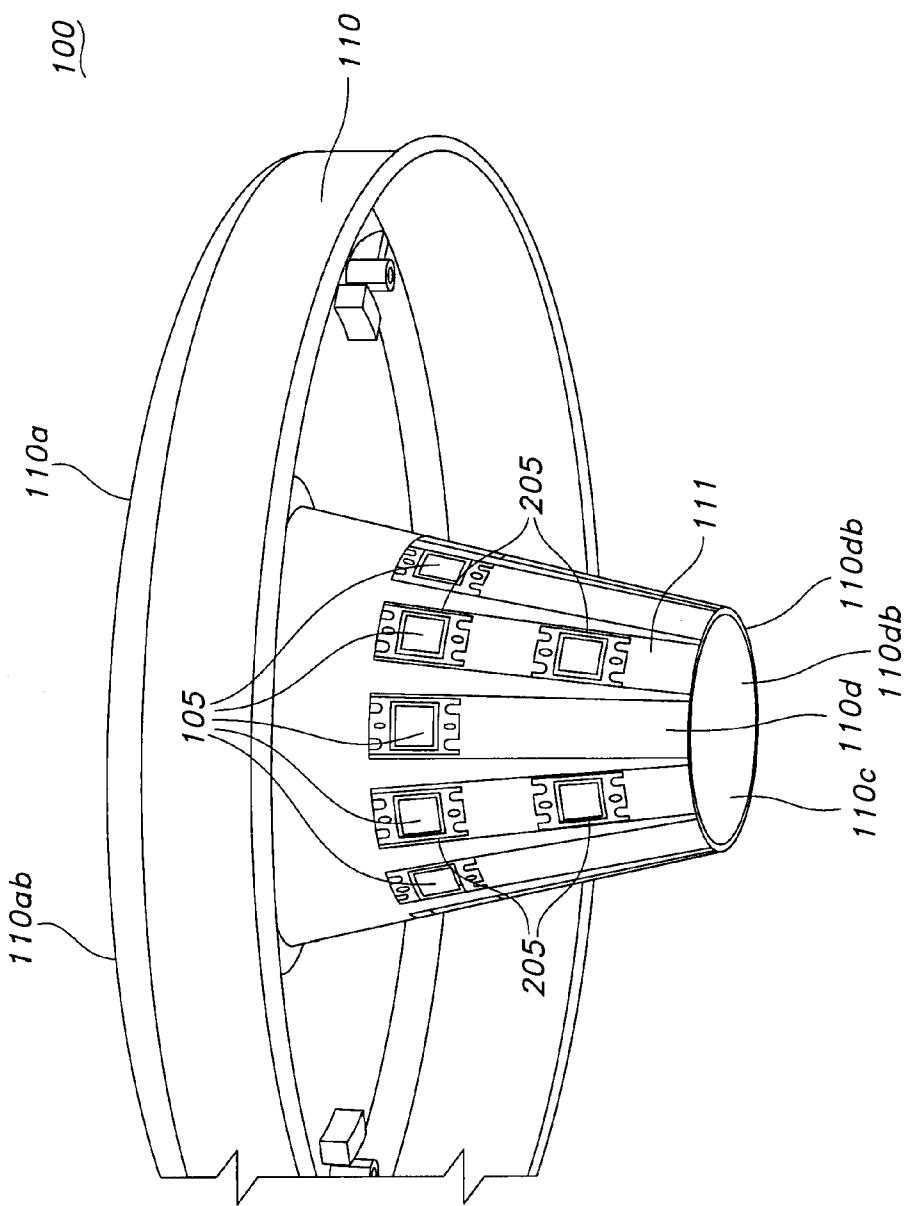


FIG. 2

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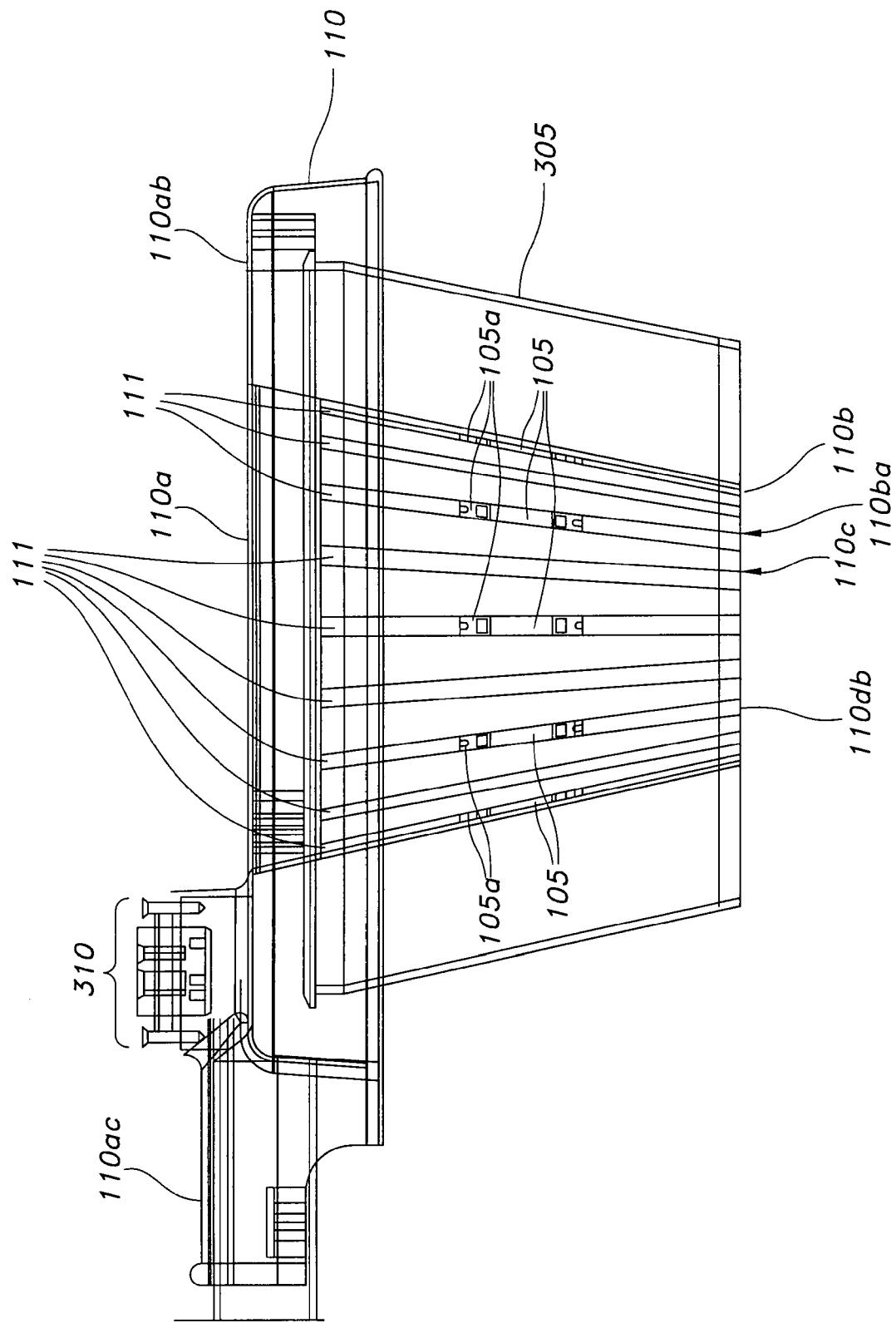


FIG. 3

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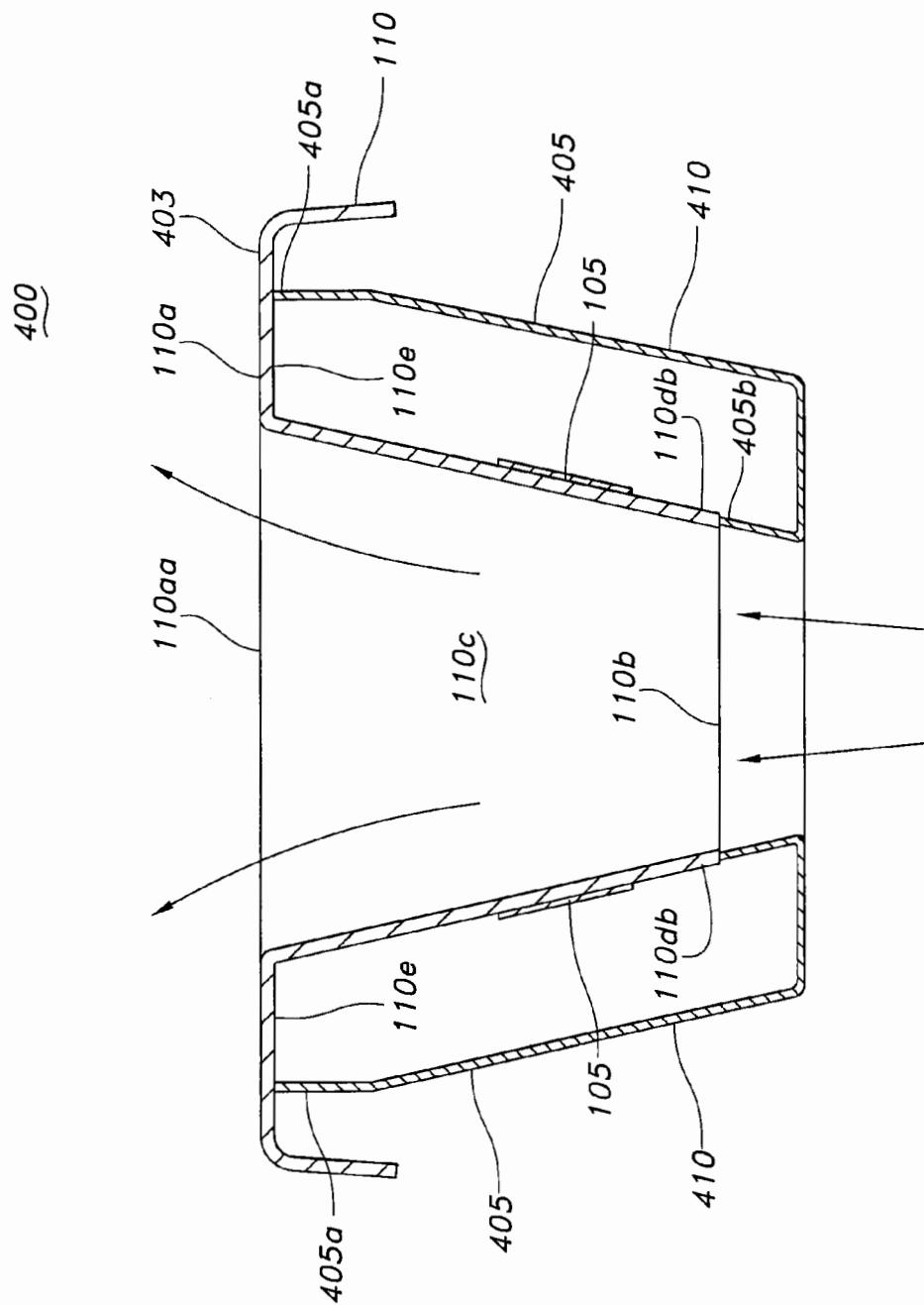


FIG. 4

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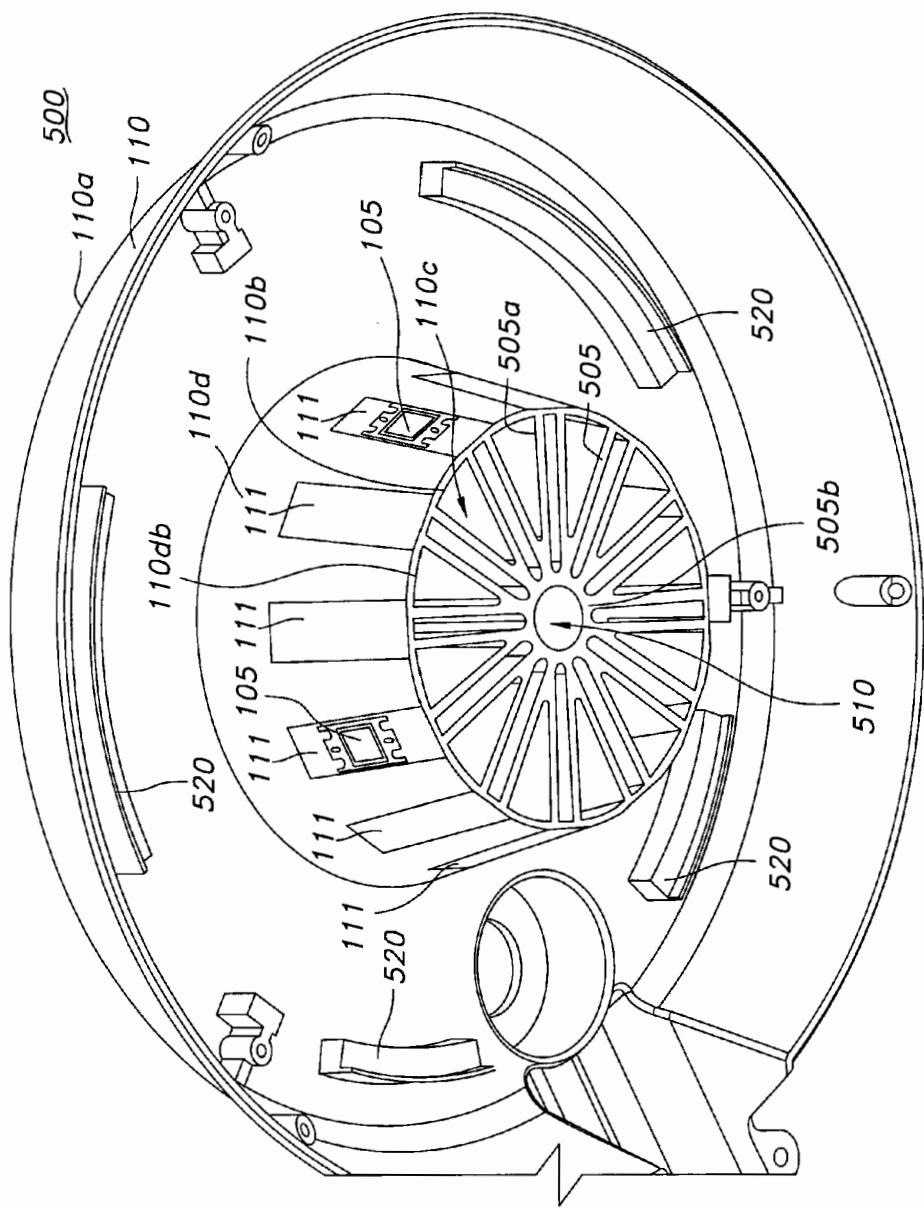


FIG. 5

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**HEAT MANAGEMENT FOR A LIGHT
FIXTURE WITH AN ADJUSTABLE OPTICAL
DISTRIBUTION**

RELATED APPLICATIONS

This patent application is a continuation of U.S. patent application Ser. No. 12/961,315 filed on Dec. 6, 2010, which is a continuation of and claims priority under 35 U.S.C. §120 to U.S. patent application Ser. No. 12/183,490 filed on Jul. 31, 2008, which claims priority under 35 U.S.C. §119 to U.S. Provisional Patent Application No. 60/994,371, titled “Flexible Light Emitting Diode Optical Distribution,” filed Sep. 19, 2007. In addition, this patent application is related to U.S. patent application Ser. No. 12/183,499 titled “Light Fixture With An Adjustable Optical Distribution,” filed Jul. 31, 2008. The complete disclosure of each of the foregoing priority and related applications is hereby fully incorporated by reference herein.

TECHNICAL FIELD

The invention relates generally to light fixtures and more particularly to light fixtures with adjustable optical distributions.

BACKGROUND

A luminaire is a system for producing, controlling, and/or distributing light for illumination. For example, a luminaire includes a system that outputs or distributes light into an environment, thereby allowing certain items in that environment to be visible. Luminaires are used in indoor or outdoor applications.

A typical luminaire includes one or more light emitting elements, one or more sockets, connectors, or surfaces configured to position and connect the light emitting elements to a power supply, an optical device configured to distribute light from the light emitting elements, and mechanical components for supporting or suspending the luminaire. Luminaires are sometimes referred to as “lighting fixtures” or as “light fixtures.” A light fixture that has a socket, connector, or surface configured to receive a light emitting element, but no light emitting element installed therein, is still considered a luminaire. That is, a light fixture lacking some provision for full operability may still fit the definition of a luminaire. The term “light emitting element” is used herein to refer to any device configured to emit light, such as a lamp or a light-emitting diode (“LED”).

Optical devices are configured to direct light energy emitted by light emitting elements into one or more desired areas. For example, optical devices may direct light energy through reflection, diffusion, baffling, refraction, or transmission through a lens. Lamp placement within the light fixture also plays a significant role in determining light distribution. For example, a horizontal lamp orientation typically produces asymmetric light distribution patterns, and a vertical lamp orientation typically produces a symmetric light distribution pattern.

Different lighting applications require different optical distributions. For example, a lighting application in a large, open environment may require a symmetric, square distribution that produces a wide, symmetrical pattern of uniform light. Another lighting application in a smaller or narrower environment may require a non-square distribution that produces a focused pattern of light. For example, the amount and direc-

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tion of light required from a light fixture used on a street pole depends on the location of the pole and the intended environment to be illuminated.

Traditional light fixtures are configured to only output light in a single, predetermined distribution. To change an optical distribution in a given environment, a person must uninstall an existing light fixture and install a new light fixture with a different optical configuration. These steps are cumbersome, time consuming, and expensive.

Therefore, a need exists in the art for an improved means for adjusting optical distribution of a light fixture. In particular, a need exists in the art for efficient, user-friendly, and cost-effective systems and methods for adjusting light emitting diode optical distribution of a light fixture.

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SUMMARY

The invention provides an improved means for adjusting optical distribution of a light fixture. In particular, the invention provides a light fixture with an adjustable optical distribution. The light fixture can be used in indoor and/or outdoor applications.

The light fixture includes a member having multiple surfaces disposed at least partially around a channel extending through the member. The member can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member can have a frusto-conical or cylindrical shape.

Each surface is configured to receive at least one LED. For example, each surface can receive one or more LEDs in a linear or non-linear array. Each surface can be integral to the member or coupled thereto. For example, the surfaces can be formed on the member via molding, casting, extrusion, or die-based material processing. Alternatively, the surfaces can be mounted or attached to the member by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other fastening means.

Each LED can be removably coupled to a respective one of the surfaces. For example, each LED can be mounted to its respective surface via a substrate that includes one or more sheets of ceramic, metal, laminate, or another material. The optical distribution of the light fixture can be adjusted by changing the output direction and/or intensity of one or more of the LEDs. In other words, the optical distribution of the light fixture can be adjusted by mounting additional LEDs to certain surfaces, removing LEDs from certain surfaces, and/or by changing the position and/or configuration of one or more of the LEDs across the surfaces or along particular surfaces. For example, one or more of the LEDs can be repositioned along a different surface, repositioned in a different location along the same surface, removed from the member, or reconfigured to have a different level of electric power to adjust the optical distribution of the light fixture. A given light fixture can be adjusted to have any number of optical distributions. Thus, the light fixture provides flexibility in establishing and adjusting optical distribution.

As a byproduct of converting electricity into light, LEDs generate a substantial amount of heat. The member can be configured to manage heat output by the LEDs. Specifically, the channel extending through the member is configured to transfer the heat output from the LEDs by convection. Heat from the LEDs is transferred to the surfaces by conduction and to the channel, which convects the heat away. For example, the channel can transfer heat by the venturi effect.

The shape of the channel can correspond to the shape of the member. For example, if the member has a frusto-conical shape, the channel can have a wide top end and a narrower

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bottom end. Alternatively, the shape of the channel can be independent of the shape of the member.

Fins can be disposed within the channel to assist with the heat transfer. For example, the fins can extend from the surfaces into the channel, towards a core region of the member. The core region can include a point where the fins converge. In addition, or in the alternative, the core region can include a member disposed within and extending along the channel and having a shape defining a second, inner channel that extends through the member. The fins can be configured to transfer heat by conduction from the facets to the inner channel. Like the outer channel, the inner channel can be configured to transfer at least a portion of that heat through convection. This air movement assists in dissipating heat generated by the LEDs.

These and other aspects, features and embodiments of the invention will become apparent to a person of ordinary skill in the art upon consideration of the following detailed description of illustrated embodiments exemplifying the best mode for carrying out the invention as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention and the advantages thereof, reference is now made to the following description, in conjunction with the accompanying figures briefly described as follows.

FIG. 1 is a perspective view of a light fixture with an optical distribution capable of being adjusted, according to certain exemplary embodiments.

FIG. 2 is another perspective view of the exemplary light fixture of FIG. 1, wherein the light fixture has a different optical distribution than that illustrated in FIG. 1.

FIG. 3 is a side elevational view of a light fixture with an optical distribution capable of being adjusted, according to certain alternative exemplary embodiments.

FIG. 4 is a cross-sectional side view of a light fixture with an optical distribution capable of being adjusted, according to another alternative exemplary embodiment.

FIG. 5 is a perspective view of a light fixture with an optical distribution capable of being adjusted, according to yet another alternative exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

The present invention is directed to systems for adjusting optical distribution of a light fixture. In particular, the invention provides efficient, user-friendly, and cost-effective systems for adjusting optical distribution of a light fixture. The term "optical distribution" is used herein to refer to the spatial or geographic dispersion of light within an environment, including a relative intensity of the light within one or more regions of the environment.

Turning now to the drawings, in which like numerals indicate like elements throughout the figures, exemplary embodiments of the invention are described in detail. FIG. 1 is a perspective view of a light fixture 100 with an optical distribution capable of being adjusted, according to certain exemplary embodiments. FIG. 2 is another perspective view of the light fixture 100, wherein the light fixture 100 has a different optical distribution than that illustrated in FIG. 1. With reference to FIGS. 1 and 2, the light fixture 100 is an electrical device configured to create artificial light or illumination in an indoor and/or outdoor environment. For example, the light fixture 100 is suited for mounting to a pole (not shown) or similar structure, for use as a street light.

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In the exemplary embodiments depicted in FIGS. 1 and 2, the light fixture 100 is configured to create artificial light or illumination via one or more LEDs 105. Each LED 105 is mounted to an outer surface 111 of a housing 110. The housing 110 includes a top end 110a and a bottom end 110b. Each end 110a and 110b includes an aperture 110aa (FIG. 4) and 110ba, respectively. A channel 110c extends through the housing 110 and connects the apertures 110aa and 110ba. The top end 110a includes a substantially round top surface 110ab disposed around the channel 110c. A mounting member 110ac extends outward from the top surface 110ab, in a direction away from the channel 110c. The mounting member 110ac is configured to be coupled to the pole, for mounting the light fixture 100 thereto.

In certain exemplary embodiments, a light-sensitive photocell 310 is coupled to the mounting member 110ac. The photocell 310 is configured to change electrical resistance in a circuit that includes one or more of the LEDs 105, based on incident light intensity. For example, the photocell 310 can cause the LEDs 105 to output light at dusk but not to output light at dawn.

A member 110d extends downward from the top surface 110ab, around the channel 110c. The member 110d has a frusto-conical geometry, with a top end 110da and a bottom end 110db that has a diameter that is less than a diameter of the top end 110da. Each outer surface 111 includes a substantially flat, curved, angular, textured, recessed, protruding, bulbous, and/or other-shaped surface disposed along an outer perimeter of the member 110d. For simplicity, each outer surface 111 is referred to herein as a "facet." The LEDs 105 can be mounted to the facets 111 by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other means known to a person of ordinary skill in the art having the benefit of the present disclosure.

In the exemplary embodiments depicted in FIGS. 1 and 2, the housing 110 includes twenty facets 111. The number of facets 111 can vary depending on the size of the LEDs 105, the size of the housing 110, cost considerations, and other financial, operational, and/or environmental factors known to a person of ordinary skill in the art having the benefit of the present disclosure. As will be readily apparent to a person of ordinary skill in the art, a larger number of facets 111 corresponds to a higher level of flexibility in adjusting the optical distribution of the light fixture 100. In particular, as described below, each facet 111 is configured to receive one or more LEDs 105 in one or more positions. The greater the number of facets 111 present on the member 110d, the greater the number of LED 105 positions, and thus optical distributions, available.

In the embodiments depicted in FIGS. 1 and 2, the end 110a and member 110d are integral to the housing 110, and the facets 111 are integral to the member 110d. In certain exemplary embodiments, the housing 110 and/or the end 110a, member 110d, and/or facets 111 thereof can be formed via molding, casting, extrusion, or die-based material processing. For example, the housing 110 and facets 111 can be comprised of die-cast aluminum. In certain alternative exemplary embodiments, the end 110a, member 110d, and/or facets 111 include separate components coupled together to form the housing 110. For example, the facets 111 can be mounted or attached to the member 110d by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other attachment means known to a person of ordinary skill in the art having the benefit of the present disclosure.

Each facet 111 is configured to receive a column of one or more LEDs 105. The term "column" is used herein to refer to

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an arrangement or a configuration whereby one or more LEDs **105** are disposed approximately in or along a line. LEDs **105** in a column are not necessarily in perfect alignment with one another. For example, one or more LEDs **105** in a column might be slightly out of perfect alignment due to manufacturing tolerances or assembly deviations. In addition, LEDs **105** in a column might be purposely staggered in a non-linear arrangement. Each column extends along an axis of its associated facet **111**.

In certain exemplary embodiments, each LED **105** is mounted to its corresponding facet **111** via a substrate **105a**. Each substrate **105a** includes one or more sheets of ceramic, metal, laminate, or another material. Each LED **105** is attached to its respective substrate **105a** by a solder joint, a plug, an epoxy or bonding line, or another suitable provision for mounting an electrical/optical device on a surface. Each substrate **105a** is connected to support circuitry (not shown) or a driver (not shown) for supplying electrical power and control to the associated LED **105**. The support circuitry (not shown) includes one or more transistors, operational amplifiers, resistors, controllers, digital logic elements, or the like for controlling and powering the LED **105**.

In certain exemplary embodiments, the LEDs **105** include semiconductor diodes configured to emit incoherent light when electrically biased in a forward direction of a p-n junction. For example, each LED **105** can emit blue or ultraviolet light. The emitted light can excite a phosphor that in turn emits red-shifted light. The LEDs **105** and the phosphors can collectively emit blue and red-shifted light that essentially matches blackbody radiation. The emitted light approximates or emulates incandescent light to a human observer. In certain exemplary embodiments, the LEDs **105** and their associated phosphors emit substantially white light that may seem slightly blue, green, red, yellow, orange, or some other color or tint. Exemplary embodiments of the LEDs **105** can include indium gallium nitride ("InGaN") or gallium nitride ("GaN") for emitting blue light.

In certain exemplary embodiments, one or more of the LEDs **105** includes multiple LED elements (not shown) mounted together on a single substrate **105a**. Each of the LED elements can produce the same or a distinct color of light. The LED elements can collectively produce substantially white light or light emulating a blackbody radiator. In certain exemplary embodiments, some of the LEDs **105** produce one color of light while others produce another color of light. Thus, in certain exemplary embodiments, the LEDs **105** provide a spatial gradient of colors.

In certain exemplary embodiments, optically transparent or clear material (not shown) encapsulates each LED **105** and/or LED element, either individually or collectively. This material provides environmental protection while transmitting light. For example, this material can include a conformal coating, a silicone gel, cured/curable polymer, adhesive, or some other material known to a person of ordinary skill in the art having the benefit of the present disclosure. In certain exemplary embodiments, phosphors configured to convert blue light to light of another color are coated onto or dispersed in the encapsulating material.

The optical distribution of the light fixture **100** depends on the positioning and configuration of the LEDs **105** within the facets **111**. For example, as illustrated in FIG. 1 and FIG. 3, described below, positioning multiple LEDs **105** symmetrically along the outer perimeter of the member **110d**, in a polar array, can create a type V symmetric distribution of light. Outdoor area and roadway luminaires are designed to distribute light over different areas, classified with designations I, II, III, IV, and V. Generally, type II distributions are wide, asym-

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metric light patterns used to light narrow roadways (i.e. 2 lanes) from the edge of the roadway. Type III asymmetric distributions are not quite as wide as type II distributions but throw light further forward for wider roadways (i.e. 3 lanes). 5 Similarly, a type IV asymmetric distribution is not as wide as the type III distribution but distributes light further forward for wider roadways (4 lanes) or perimeters of parking lots. A type V distribution produces a symmetric light pattern directly below the luminaire, typically either a round or square pattern of light. For example, positioning LEDs **105** only in three adjacent facets **111** can create a type IV asymmetric distribution of light.

As illustrated in FIG. 2, positioning multiple LEDs **105** in the same facet **111** increases directional intensity of the light relative to the facet **111** (as compared to a facet **111** with only one or no LEDs **105**). For example, positioning the LEDs **105** in a linear array **205** along the facet **111** increases directional intensity of the light substantially normal to the axis of the facet **111**. Directional intensity also can be adjusted by 10 increasing or decreasing the electric power to one or more of the LEDs **105**. For example, overdriving one or more LEDs **105** increases the directional intensity of the light from the LEDs **105** in a direction normal to the corresponding facet **111**. Similarly, using LEDs **105** with different sizes and/or wattages can adjust directional intensity. For example, replacing an LED **105** with another LED **105** that has a higher wattage can increase the directional intensity of the light from the LEDs **105** in a direction normal to the corresponding facet **111**.

30 The optical distribution of the light fixture **100** can be adjusted by changing the output direction and/or intensity of one or more of the LEDs **105**. In other words, the optical distribution of the light fixture **100** can be adjusted by mounting additional LEDs **105** to the member **110d**, removing LEDs **105** from the member **110d**, and/or by changing the position and/or configuration of one or more of the LEDs **105**. For example, one or more of the LEDs **105** can be repositioned in a different facet **111**, repositioned in a different location within the same facet **111**, removed from the light fixture **100**, or reconfigured to have a different level of electric power. A given light fixture **100** can be adjusted to have any number of optical distributions.

40 For example, if a particular lighting application only requires light to be emitted towards one direction, LEDs **105** can be placed only on facets **111** corresponding to that direction. If the intensity of the emitted light in that direction is too low, the electric power to the LEDs **105** may be increased, and/or additional LEDs **105** may be added to those facets **111**. Similarly, if the intensity of the emitted light in that direction is too high, the electric power to the LEDs **105** may be decreased, and/or one or more of the LEDs **105** may be removed from the facets **111**. If the lighting application changes to require a larger beam spread of light in multiple directions, additional LEDs **105** can be placed on empty, 50 adjacent facets **111**. In addition, the beam spread may be tightened by moving one or more of the LEDs **105** downward within their respective facets **111**, towards the bottom end **110db**. Similarly, the beam spread may be broadened by moving one or more of the LEDs **105** upwards within their respective facets **111**, towards the top end **110da**. Thus, the light fixture **100** provides flexibility in establishing and adjusting optical distribution.

60 Although illustrated in FIGS. 1 and 2 as having a frustoconical geometry, a person of ordinary skill in the art having the benefit of the present disclosure will recognize that the member **110d** can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the mem-

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ber 110d can have a cylindrical shape. Similarly, although illustrated as having a substantially vertical orientation, each facet 111 may have any orientation, including, but not limited to, a horizontal or angular orientation, in certain alternative exemplary embodiments.

The level of light a typical LED 105 outputs depends, in part, upon the amount of electrical current supplied to the LED 105 and upon the operating temperature of the LED 105. Thus, the intensity of light emitted by an LED 105 changes when electrical current is constant and the LED's 105 temperature varies or when electrical current varies and temperature remains constant, with all other things being equal. Operating temperature also impacts the usable lifetime of most LEDs 105.

As a byproduct of converting electricity into light, LEDs 105 generate a substantial amount of heat that raises the operating temperature of the LEDs 105 if allowed to accumulate on the LEDs 105, resulting in efficiency degradation and premature failure. The member 110d is configured to manage heat output by the LEDs 105. Specifically, the frusto-conical shape of the member 110d creates a venturi effect, drawing air through the channel 110c. The air travels from the bottom end 110db of the member 110d, through the channel 110c, and out the top end 110da. This air movement assists in dissipating heat generated by the LEDs 105. Specifically, the air dissipates the heat away from the member 110d and the LEDs 105 thereon. Thus, the member 110d acts as a heat sink for the LEDs 105 positioned within or along the facets 111.

FIG. 3 is a side elevational view of a light fixture 300 with an optical distribution capable of being adjusted. The light fixture 300 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 300 includes a cover 305. The cover 305 is an optically transmissive element that provides protection from dirt, dust, moisture, and the like. The cover 305 is disposed at least partially around the facets 111, with a top end thereof being coupled to the top surface 110ab of the housing 110. In certain exemplary embodiments, the cover 305 is configured to control light from the LEDs 105 via refraction, diffusion, or the like. For example, the cover 305 can include a refractor, a lens, an optic, or a milky plastic or glass element.

FIG. 4 is a cross-sectional side view of a light fixture 400 with an optical distribution capable of being adjusted, according to another alternative exemplary embodiment. Like the light fixture 300 of FIG. 3, the light fixture 400 is identical to the light fixture 100 of FIGS. 1 and 2 except that the light fixture 400 includes a cover 405. The cover 405 includes an optically transmissive element 410 that provides protection from dirt, dust, moisture, and the like. The cover 405 is disposed at least partially around the facets 111, with a top end 405a thereof being attached to a bottom surface 110e of the top end 110a of the housing 110. For example, the top end 405a can be attached to one or more ledges 520 (shown in FIG. 5) extending from the bottom surface 110e of the housing 110. Another end 405b of the cover 405 is attached to the bottom end 110db of the member 110d. In certain exemplary embodiments, there is a sealing element (not shown) between the cover 405 and the member 110d, at one or more points of attachment. In certain exemplary embodiments, the cover 405 is configured to control light from the LEDs 105 via refraction, diffusion, or the like. For example, the cover 405 can include a refractor, a lens, an optic, or a milky plastic or glass element.

FIG. 5 is a perspective view of a light fixture 500 with an optical distribution capable of being adjusted, according to yet another alternative exemplary embodiment. The light fixture 500 is identical to the light fixture 100 of FIGS. 1 and 2

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except that the light fixture 500 includes one or more fins 505 acting as heat sinks for managing heat produced by the LEDs 105. In certain exemplary embodiments, each fin 505 is associated with a facet 111 and includes an elongated member 505a that extends from an interior surface (of the member 110d) opposite its associated facet 111, within the channel 110c, to a core region 505b. A channel 510 extends through the core region 505b, within the channel 110c. The fins 505 are spaced annularly around the channel 510. Alternatively, one or more of the fins 505 can be independent of the facets 111 and can be positioned radially in a symmetrical or non-symmetrical pattern.

Heat transfers from the LEDs 105 via a heat-transfer path extending from the LEDs 105, through the member 110d, and to the fins 505. For example, the heat 105 from a particular LED 105 transfers from the substrate 105a of the LED 105 to its corresponding facet 111, and from the facet 111 through the member 110d to the corresponding fin 505. The fins 505 receive the conducted heat and transfer the conducted heat to the surrounding environment (typically air) via convection.

The channel 510 supports convection-based cooling. For example, as described above in connection with FIGS. 1 and 2, the frusto-conical shape of the member 110d creates a venturi effect, drawing air through the channel 510. The air travels from the bottom end 110b of the housing 110, through the channel 510, and out the top end 110a. This air movement assists in dissipating heat generated by the LEDs 105 away from the LEDs 105. In certain alternative exemplary embodiments, the fins 505 converge within the channel 110c so that there is not an inner channel 510 within the channel 110c. In such an embodiment, the channel 110c supports convection-based cooling substantially as described above.

In the embodiment depicted in FIG. 5, the fins 505 are integral to the member 110d. In certain exemplary embodiments, the fins 505 can be formed on the member 110d via molding, casting, extrusion, or die-based material processing. For example, the member 110d and fins 505 can be comprised of die-cast aluminum. Alternatively, the fins 505 can be mounted or attached to the member 110d by solder, braze, welds, glue, plug-and-socket connections, epoxy, rivets, clamps, fasteners, or other fastening means known to a person of ordinary skill in the art having the benefit of the present disclosure. Like the light fixtures 300 and 400 of FIGS. 3 and 4, respectively, in certain alternative exemplary embodiments, the light fixture 500 can be modified to include a cover (not shown).

Although illustrated in FIG. 5 as having a frusto-conical geometry, a person of ordinary skill in the art having the benefit of the present disclosure will recognize that the member 110d can have any shape, whether polar or non-polar, symmetrical or asymmetrical. For example, the member 110d can have a cylindrical shape.

Although specific embodiments of the invention have been described above in detail, the description is merely for purposes of illustration. It should be appreciated, therefore, that many aspects of the invention were described above by way of example only and are not intended as required or essential elements of the invention unless explicitly stated otherwise. Various modifications of, and equivalent steps corresponding to, the disclosed aspects of the exemplary embodiments, in addition to those described above, can be made by a person of ordinary skill in the art, having the benefit of this disclosure, without departing from the spirit and scope of the invention defined in the following claims, the scope of which is to be accorded the broadest interpretation so as to encompass such modifications and equivalent structures.

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What is claimed is:

1. A light fixture, comprising:
a first member comprising:

a top end;

a bottom end; and

an exterior surface extending from the top end to the bottom end,

wherein the first member comprises a first aperture adjacent the top end, a second aperture adjacent the bottom end, and a channel extending from the first aperture to the second aperture and defined by an interior surface of the first member, the interior surface facing an opposite direction than the exterior surface;

a plurality of light emitting diodes (LEDs) disposed on the exterior surface of the first member, wherein at least one LED is disposed on a first portion of the exterior surface and at least another LED is disposed on a second portion of the exterior surface different than the first portion;

a second member comprising an adjacent end, a distal end, and a side surface extending from the adjacent end to the distal end, at least a portion of the second member being disposed above the LEDs, the second member being coupled to the first member; and

a mounting member coupled to the second member, at least a portion of the mounting member extending in a direction substantially orthogonal to a longitudinal axis of the first member.

2. The light fixture of claim 1, wherein one or more LEDs are disposed on a plurality of portions of the exterior surface, each of the plurality of portions of the exterior surface being equidistant from an adjacent portion of the exterior surface.

3. The light fixture of claim 1, wherein the exterior surface of the first member comprises at least one facet, the LEDs being disposed on the facet.

4. The light fixture of claim 1, wherein the perimeter of the top end is larger than the perimeter of the bottom end.

5. The light fixture of claim 1, wherein the plurality of LEDs are asymmetrically disposed about the first member and configured to emit an asymmetric light output.

6. The light fixture of claim 1, further comprising an optically transmissive cover disposed at least partially around the first member.

7. The light fixture of claim 1, further comprising:
a driver electrically coupled to at least one of the plurality of LEDs to control the at least one of the plurality of LEDs; and
a photocell electrically coupled to the driver.

8. The light fixture of claim 1, further comprising a plurality of receiving surfaces on the exterior surface, each receiving surface configured to receive at least one LED and wherein the plurality of receiving surfaces provide a plurality of different configuration for a positioning of the plurality of LEDs, each of the plurality of different configuration corresponding to a different optical distribution of the light fixture.

9. A light fixture, comprising:
a first member comprising:

a top end;

a bottom end; and

an exterior surface extending from the top end to the bottom end,

wherein the first member comprises a first aperture adjacent the top end, a second aperture adjacent the bottom end, and a channel extending from the first aper-

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ture to the second aperture and defined by an interior surface of the first member, the interior surface facing an opposite direction than the exterior surface;

a plurality of light emitting diodes (LEDs) disposed on the exterior surface of the first member, wherein at least one LED is disposed on a first portion of the exterior surface and at least another LED is disposed on a second portion of the exterior surface different than the first portion;
a second member comprising an adjacent end, a distal end, and a side surface extending from the adjacent end to the distal end, at least a portion of the second member being disposed above the LEDs, the second member being coupled to the first member;

a mounting member coupled to the second member, at least a portion of the mounting member extending in a direction substantially orthogonal to a longitudinal axis of the first member; and

a lens coupled to the second member and disposed at least partially around the first member.

10. The light fixture of claim 9, wherein one or more LEDs are disposed on a plurality of portions of the exterior surface, each of the plurality of portions of the exterior surface being equidistant from an adjacent portion of the exterior surface.

11. The light fixture of claim 9, wherein the first aperture has a first diameter and the second aperture has a second diameter and wherein the first and second diameters are different.

12. The light fixture of claim 9, wherein the top end has a first perimeter and the bottom end has a second perimeter and wherein the first and second perimeters are different.

13. The light fixture of claim 9, wherein the plurality of LEDs are asymmetrically disposed about the first member and configured to emit an asymmetric light output.

14. The light fixture of claim 9, further comprising:
a driver electrically coupled to at least one of the plurality of LEDs to control the at least one of the plurality of LEDs; and
a photocell electrically coupled to the driver.

15. A light fixture, comprising:
a member comprising:
an interior surface;
a first aperture;
a second distal aperture, and
a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface of the member;

at least one first light emitting diode (LED) coupled adjacent a first side of the channel; and
at least one second LED coupled adjacent a second side of the channel, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.

16. The light fixture of claim 15, wherein the second side of the channel is opposite the first side of the channel.

17. The light fixture of claim 15, wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.

18. The light fixture of claim 15, wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.

* * * * *

EXHIBIT 5



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312.241.1529 (Fax)

June 26, 2020

Re: Lighting Defense Group, LLC Patent License Opportunity; U.S. Patent Nos. 8,256,923; 8,939,608; 7,874,700; 9,163,807

Dear Mr. Chen,

We represent Lighting Defense Group, LLC (“**LDG**”), a Delaware Corporation with its principal place of business at 4260 North Brown Avenue Suite # 8, Scottsdale, AZ 85251. This letter is to notify you of your company’s need for a license to at least the above referenced U.S. Patent numbers 8,256,923 (“the ‘923 patent”), 8,939,608 (“the ‘608 patent”), 7,874,700 (“the ‘700 patent”) and 9,163,807 (“the ‘807 patent”).

About LDG

LDG is the owner of the ‘923, ‘608, ‘700, and ‘807 patents that represent a portion of the total portfolio. LDG is also the owner of 25 other issued US patents and pending applications, broken into 8 different patent families in the lighting space. The principals of LDG have consulted on lighting design and implementation issues for companies which include, but are not limited to, Costco Wholesale, Motorola, American Express, Simon Properties, Prologis, and Crate & Barrel. Additionally, LDG principals have designed and patented products which have been, and continue to be manufactured and sold globally by major US and Canadian manufacturers including Thomas & Betts/ABB, Acuity, Cooper Lighting/Signify, and Valmont Industry.

LDG’s Patented Technology

LDG’s portfolio discloses innovative cooling technology for high efficiency lighting units, including various aspects and improvements related to light emitting diode (LED) lighting technology. In particular, these patents relate to technologies that perform heat management for LED Corn Cob lights, lamps, retrofit and other lighting solutions for use, indoors, outdoors, warehouses, retail, or other use cases. The portfolio also covers technology that relates to improving the efficiency of the lighting through heat dispersion allowing the use of more efficient, longer lasting, and powerful LED lighting.

As a representative example of the technology, a copy of the ‘923 patent, which claims priority to a provisional application filed in 2007, titled “Heat Management for a Light Fixture with an Adjustable Optical Distribution” is enclosed. The ‘923 patent discloses and claims technology that, for example, provide for a light fixture that is user-friendly, efficient and cost-effective and allows for the expanded use of high efficiency LED lighting.

The '923 patent and its family members have been cited in subsequent patents and patent applications by major companies such as CREE, Cooper Technologies, Osram, Sharp, and others. Further, one of the leading companies in the lighting space has already taken a license to the portfolio.

Shanghai Sansi's Need for a License

We have conducted a preliminary investigation comparing the claims of the '923, '608, '700, and '807 patents to Shanghai Sansi's ("Sansi") Corn Lights, including at least the Sansi C21BB-WE Omnidirectional Light Bulb, Sansi C21BB-TE26 UV Light Bulb, Sansi C21BB-QE Smart RGB Light Bulb, Sansi C21BB-TE26/27 Plain Light Bulb, Sansi C21BB-RE Dimmable Light Bulb, Sansi C21BB-UE Light Bulb, Sansi C21GL-CE26/27 Full Spectrum Glow Light, Sansi C21GL-AE26 Full Cycle Glow Light, Sansi C21GL-DE26 Full Spectrum Glow Light, Sansi C21GL-CE26/27 Full Spectrum Glow Light, Sansi C21GL-AE26-Flowering Glow Light, Sansi C21BB-ZE39/E40 High Bay Light, and BR30 Non-Dimmable LED Light Bulb.

We have determined that Sansi needs a license to the '923, '608, '700, and '807 patents to continue making, using, selling, or otherwise offering these products. Enclosed are sample claim charts, including patent claim infringement analysis demonstrating that Sansi's products and services infringe at least:

- '923 Patent, Claims 1, 3, 4, 6, 12, 14, 15, 17, 18, 19, 20;
- '608 Patent, Claims 15, 16, 17, 18;
- '700 Patent, Claims 1, 2, 3, 13, 16, 17, 18, 21; and
- '807 Patent, Claims 14, 15, 16, 17, 19.

The evidence used in the claim charts are non-limiting representative examples of infringement, and there may be additional or different evidence of use. Our analysis of any particular claim does not preclude application of any other claims to any of Sansi's products and services. You may wish to examine additional products and services in relation to the claims of the '923, '608, '700, and '807 patents. You may further wish to examine LDG's other patents as they relate to Sansi's products and services, such as, for example, its related issued US patents. The LDG portfolio includes multiple pending applications providing the opportunity to present new claims that even more clearly highlight Sansi's infringement.

We would like to discuss this licensing opportunity with Sansi once it has reviewed the enclosed documents. We believe that a license would benefit Sansi by providing it the ability to practice claims of LDG's patent without violating rights under the patent. We would be happy to arrange an in-person meeting for substantive discussions for a potential license.

About Global IP Law Group, LLC

Global IP Law Group is a Chicago-based law firm focusing on helping clients monetize their patent portfolios. More information about the firm can be found at <http://www.giplg.com>.

Sincerely,



Ragnar Olson



Enclosures

Notice

For the avoidance of doubt, this letter shall not be construed to grant any express or implied license, authorization, covenant-not-to-sue, immunity, forbearance, indulgence, waiver, release or any other right with respect to Lighting Defense Group, LLC or otherwise. Lighting Defense Group, LLC reserves all rights with regard to its patents, including but not limited to: (1) the right to seek injunctive or other relief, including royalties or other damages going back at least as far as the last six years; (2) the right to change any royalty rates at any time; and (3) the right to change or withdraw any licensing offer at any time without notice. You should not rely on any communication, lack of communication, and/or any inactivity from Global IP Law Group or Lighting Defense Group, LLC as a relinquishment, acquiescence, waiver, or compromise of any of Lighting Defense Group, LLC's rights or as a change or withdrawal of any prior assertions stated. This letter and any subsequent related discussions do not create any obligation by Lighting Defense Group, LLC to proceed with any license or other contract with you. Lighting Defense Group, LLC reserves the right, in its sole discretion, to abandon or withdraw from at any time for any reason any discussions contemplated by this letter. This letter is being sent as a confidential settlement communication pursuant to Rule 408, Federal Rules of Evidence.

EXHIBIT 6

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



U.S. Patent No. 8,256,923: Sansi C21BB-ZE39/E40 High Bay Light¹

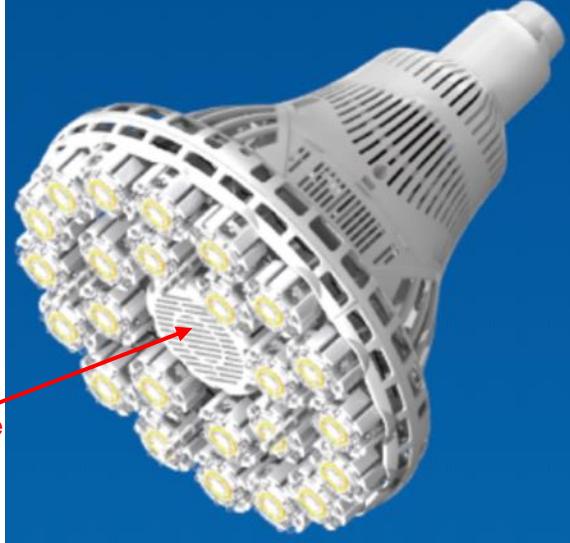
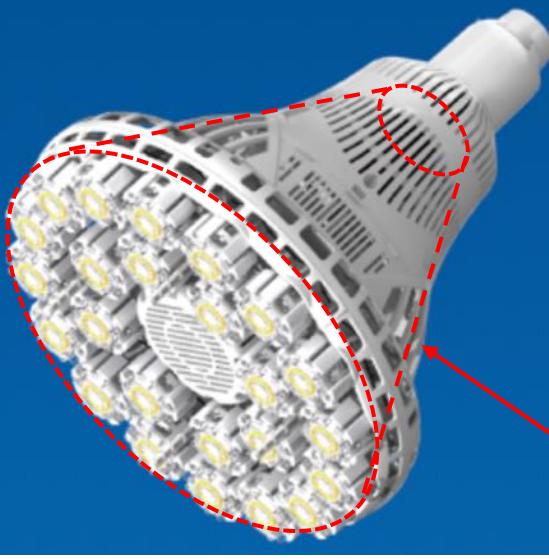
Claim 1	Analysis	Select Evidence
A light fixture, comprising: a member comprising: a top end comprising a first aperture;	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a member comprising a top end comprising a first aperture.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

¹ Although this claim chart uses Sansi C21BB-ZE39/E40 High Bay Light as an example, other products in the same family infringe this patent in the same way. Those products include, at least, Sansi C21GL-CE26/27 Full Spectrum Glow Light and BR30 Non-Dimmable LED Light Bulb.

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.

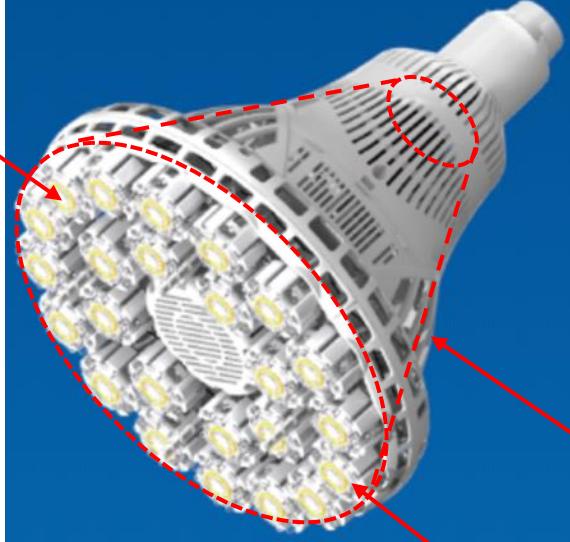
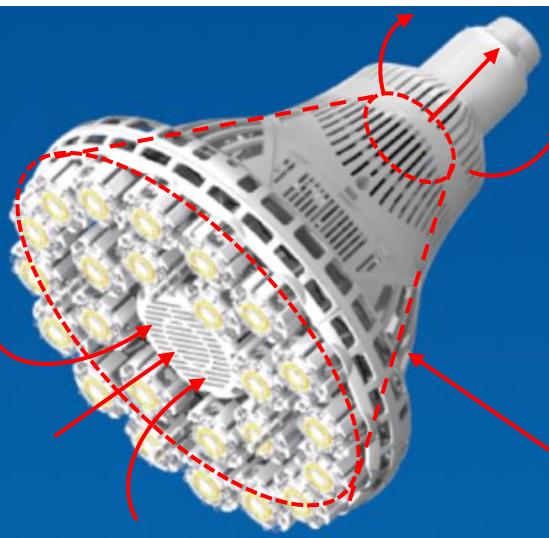
Claim 1	Analysis	Select Evidence
a bottom end comprising a second aperture,	Sansi C21BB-ZE39/E40 High Bay Light has a bottom end comprising a second aperture.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a channel extending from the first aperture to the second aperture and defined by an interior surface of the member;	Sansi C21BB-ZE39/E40 High Bay Light has a channel extending from the first aperture to the second aperture and defined by an interior surface of the member.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



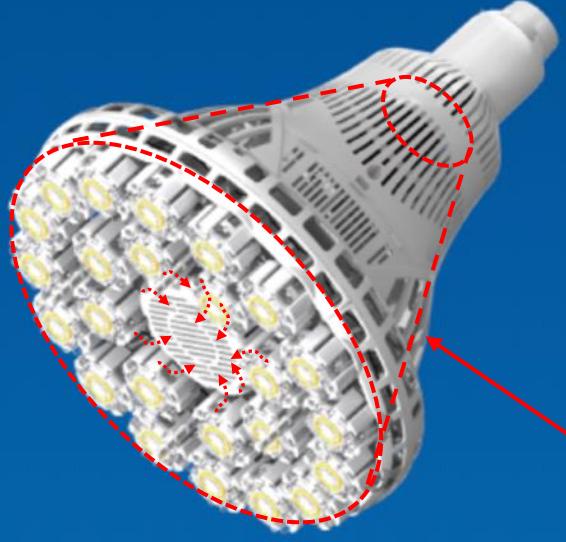
Claim 1	Analysis	Select Evidence
<p>a plurality of light emitting diodes (LEDs) disposed on the fixture adjacent to the channel, wherein at least one LED is located on one side of the channel and at least another LED is located on an opposite side of the channel;</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light has a plurality of light emitting diodes (LEDs) disposed on the fixture adjacent to the channel, wherein at least one LED is located on one side of the channel and at least another LED is located on an opposite side of the channel.</p>	 <p>The image shows a side view of the Sansi C21BB-ZE39/E40 High Bay Light. A red dashed circle highlights a cluster of yellow LED components. Red arrows point to two specific LEDs within this cluster, labeled "first LED" and "second LED". Another red arrow points to a larger, more complex red dashed circle that encloses the entire LED array and part of the internal heat sink, labeled "concealed channel (inside)".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
<p>wherein air enters the channel through the second aperture and exits the channel through the first aperture; and</p>	<p>The air enters the channels of Sansi C21BB-ZE39/E40 High Bay Light through the second aperture and exits the channel through the first aperture.</p>	 <p>The image shows a side view of the Sansi C21BB-ZE39/E40 High Bay Light. Red dashed circles indicate the flow path of air. One circle, located at the bottom, is labeled "air flows into the channel". Another circle, located at the top, is labeled "air flows out of the channel". A third circle, located on the right side, is labeled "concealed channel (inside)".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

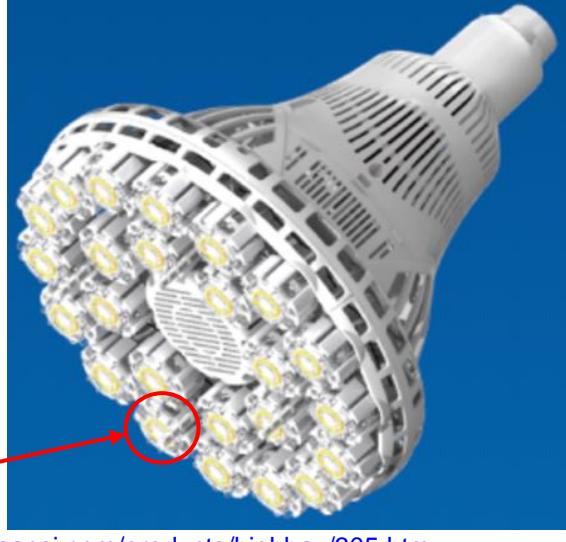
Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 1	Analysis	Select Evidence
wherein the LEDs transfer heat through the member to the air in the channel.	The LEDs on Sansi C21BB-ZE39/E40 High Bay Light transfer heat through the member to the air in the channel.	 <p data-bbox="819 535 1013 589">heat transfer into the channel</p> <p data-bbox="1613 703 1934 731">concealed channel (inside)</p>

Source: <http://www.sansi.com/products/highbay/305.htm>

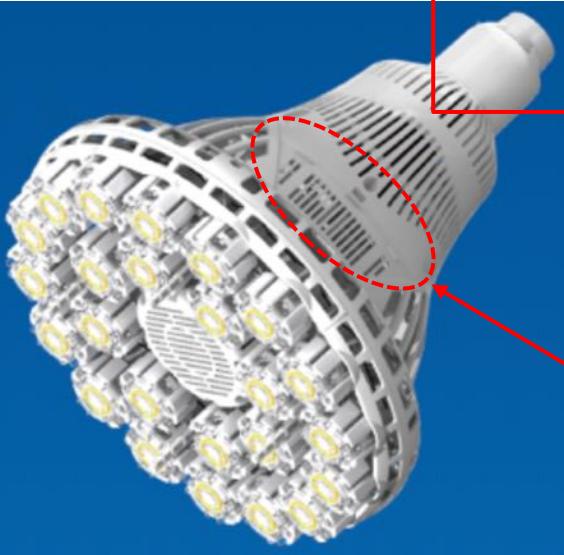
Claim 3	Analysis	Select Evidence
The light fixture of claim 1, further comprising a plurality of LED receiving surfaces, wherein the LED receiving surfaces are disposed at least partially around the channel.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a plurality of LED receiving surfaces, wherein the LED receiving surfaces are disposed at least partially around the channel.	 <p data-bbox="819 1372 1034 1400">receiving surfaces</p>

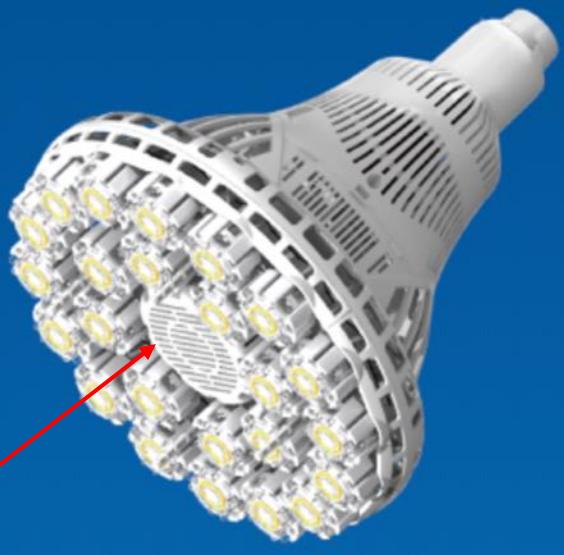
Source: <http://www.sansi.com/products/highbay/305.htm>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.

Claim 4	Analysis	Select Evidence
<p>The light fixture of claim 1, further comprising a mounting member extending outwardly in a direction substantially orthogonal to a longitudinal axis of the channel.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a mounting member extending outwardly in a direction substantially orthogonal to a longitudinal axis of the channel.</p>	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p> <p>mounting member</p> <p>longitudinal axis of the channel</p>

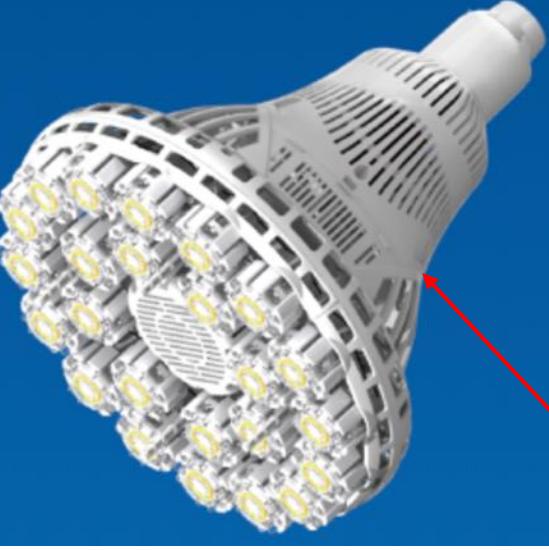
Claim 6	Analysis	Select Evidence
<p>The light fixture of claim 1, further comprising an optically transmissive cover disposed at least partially around the member.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising an optically transmissive cover disposed at least partially around the member.</p>	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p> <p>interior surface (concealed)</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 7	Analysis	Select Evidence
The light fixture of claim 1, wherein the plurality of LEDs are asymmetrically disposed about the channel and configured to emit an asymmetric light output.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture that has a plurality of LEDs that are asymmetrically disposed about the channel and configured to emit an asymmetric light output.	 <p>A photograph of a white, cylindrical LED light fixture. The fixture has a textured, ribbed exterior and a cluster of yellow LEDs at the bottom. A red arrow points from the text "exterior surface" to the top half of the fixture.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

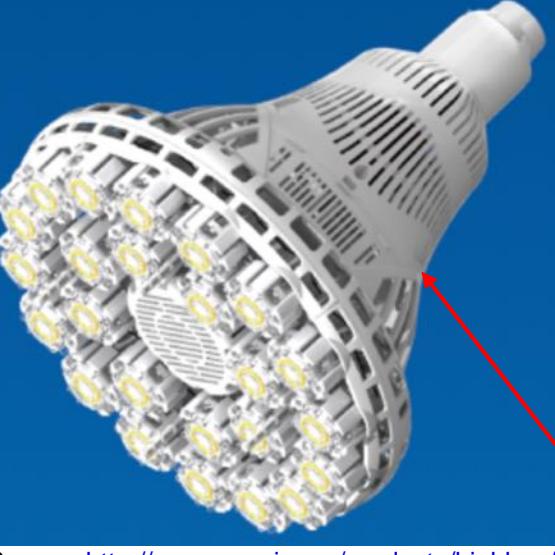
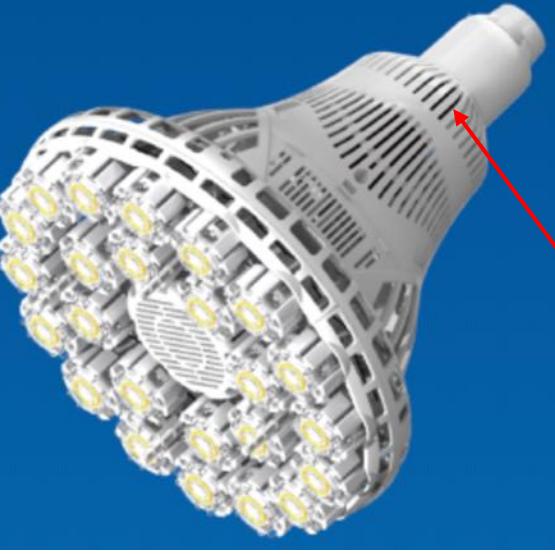
Claim 12	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an interior surface;	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a member comprising an interior surface.	 <p>A photograph of the same white, cylindrical LED light fixture. In this view, the bottom part where the LEDs are located is shown from a side-on perspective, revealing the internal structure and the "interior surface (concealed)" mentioned in the analysis. A red arrow points from the text "interior surface (concealed)" to the bottom of the fixture.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



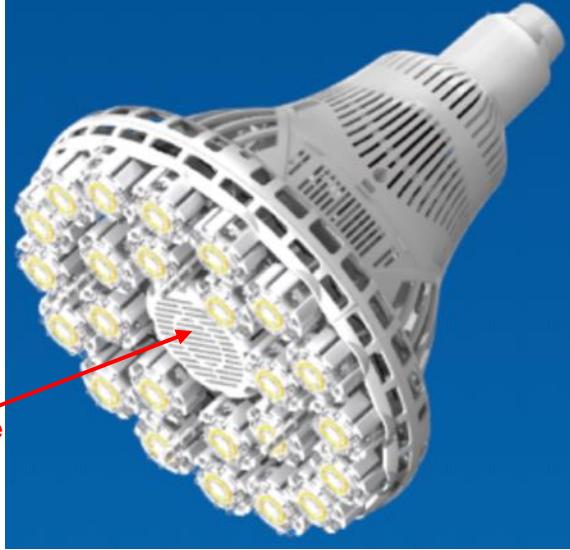
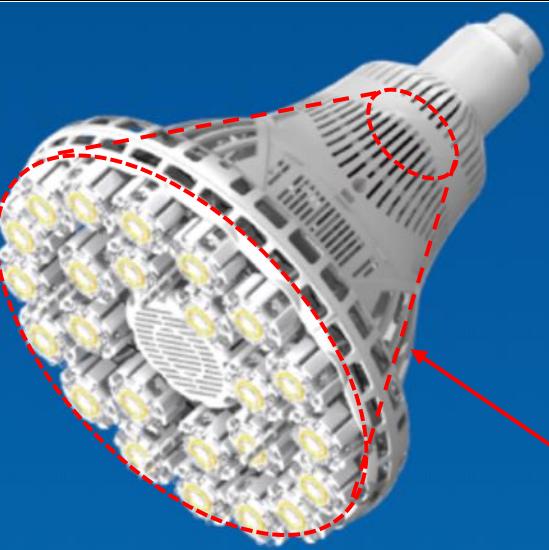
Claim 12	Analysis	Select Evidence
an exterior surface;	Sansi C21BB-ZE39/E40 High Bay Light has an exterior surface.	 <p>A photograph of a Sansi C21BB-ZE39/E40 High Bay Light bulb. The bulb is white with a textured, ribbed base. A red arrow points from the text "exterior surface" to the side of the bulb, just below the base. The background is solid blue.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a first aperture disposed along a first end;	Sansi C21BB-ZE39/E40 High Bay Light has a first aperture disposed along a first end.	 <p>A photograph of the same Sansi C21BB-ZE39/E40 High Bay Light bulb. A red arrow points from the text "first aperture" to the top edge of the bulb, where the glass is thinnest. The background is solid blue.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 12	Analysis	Select Evidence
a second aperture disposed along a distal second end;	Sansi C21BB-ZE39/E40 High Bay Light has a second aperture disposed along a distal second end.	 <p>A photograph of a white, cylindrical LED light bulb. A red arrow points to a circular opening on the side of the bulb, labeled "second aperture".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a channel extending from the first aperture to the second aperture and defined by the interior surface; and	Sansi C21BB-ZE39/E40 High Bay Light has a channel extending from the first aperture to the second aperture and defined by the interior surface.	 <p>A photograph of the same light bulb, but with a dashed red circle highlighting a specific area on the side. A red arrow points to this circle, labeled "concealed channel (inside)".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



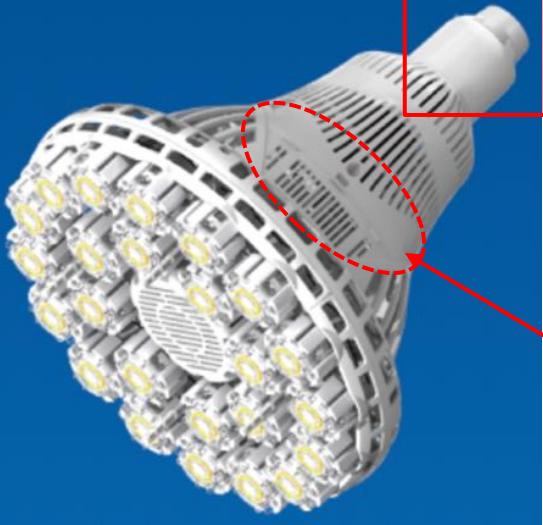
Claim 12	Analysis	Select Evidence
<p>a plurality of light emitting diodes (LEDs) positioned adjacent to the channel; wherein a first of the plurality of LEDs is disposed adjacent a first portion of the channel and a second of the plurality of LEDs is disposed adjacent a second portion of the channel different than the first portion; and</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light has a plurality of light emitting diodes (LEDs) positioned adjacent to the channel; wherein a first of the plurality of LEDs is disposed adjacent a first portion of the channel and a second of the plurality of LEDs is disposed adjacent a second portion of the channel different than the first portion.</p>	<p>Source: http://www.sansi.com/products/highbay/305.htm</p>
<p>wherein air passes through the channel from the second aperture to the first aperture and transfers at least a portion of heat generated by the first LED and the second LED through the first aperture.</p>	<p>The air passes through the channel of Sansi C21BB-ZE39/E40 High Bay Light from the second aperture to the first aperture and transfers at least a portion of heat generated by the first LED and the second LED through the first aperture.</p>	<p>Source: http://www.sansi.com/products/highbay/305.htm</p>

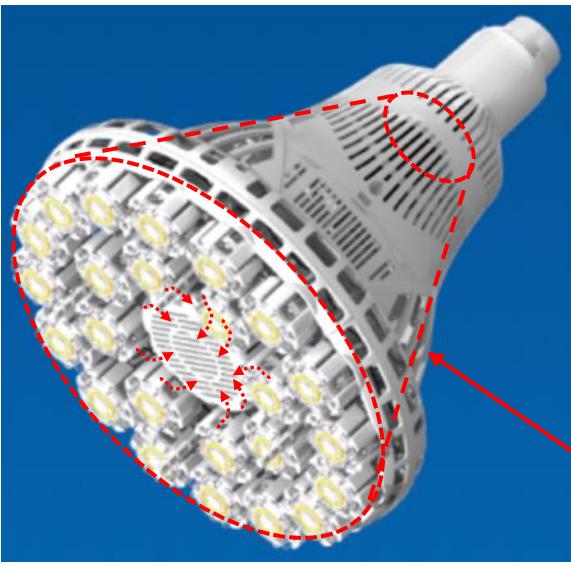
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 14	Analysis	Select Evidence
<p>The light fixture of claim 12, further comprising a mounting member extending outwardly from the member in a direction away from a longitudinal axis of the channel.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a mounting member extending outwardly from the member in a direction away from a longitudinal axis of the channel.</p>	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

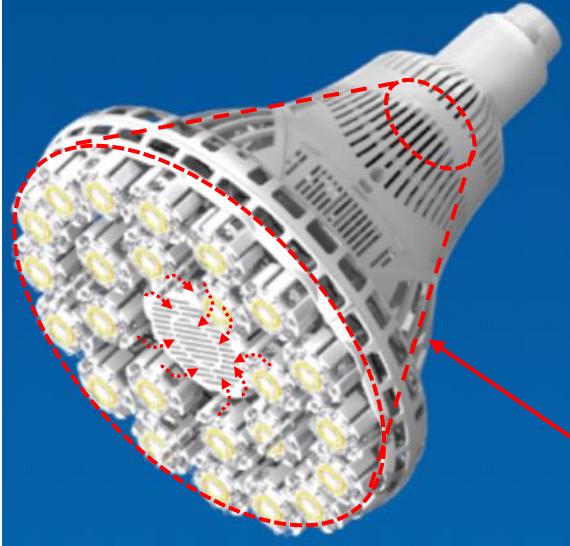
Claim 15	Analysis	Select Evidence
<p>The light fixture of claim 12, wherein the heat is transferred from the first and second LED to the member by conduction; and</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the heat is transferred from the first and second LED to the member by conduction.</p>	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

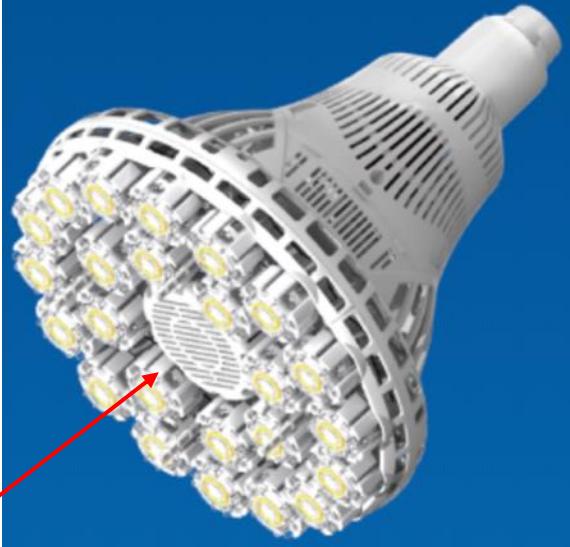
Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 15	Analysis	Select Evidence
wherein the heat is transferred from the member through the channel with the air by convection.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the heat is transferred from the member through the channel with the air by convection.	 <p data-bbox="819 577 1094 670">heat transfers from the member through the channel by convection</p> <p data-bbox="1706 708 1896 763">concealed channel (inside)</p>

Source: <http://www.sansi.com/products/highbay/305.htm>

Claim 17	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an interior surface	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture, comprising a member comprising an interior surface.	 <p data-bbox="819 1421 1157 1460">interior surface (concealed)</p>

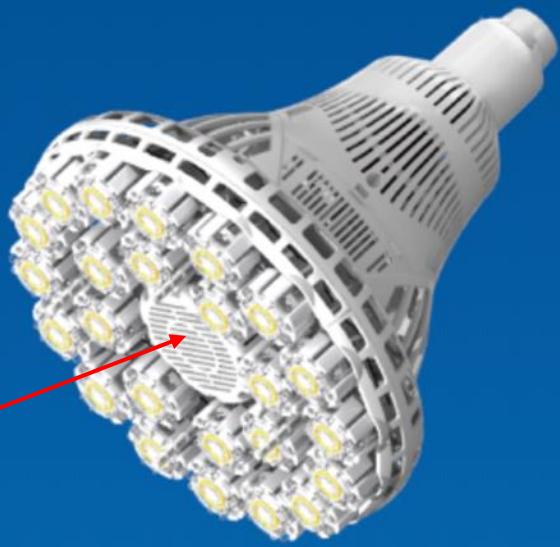
Source: <http://www.sansi.com/products/highbay/305.htm>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



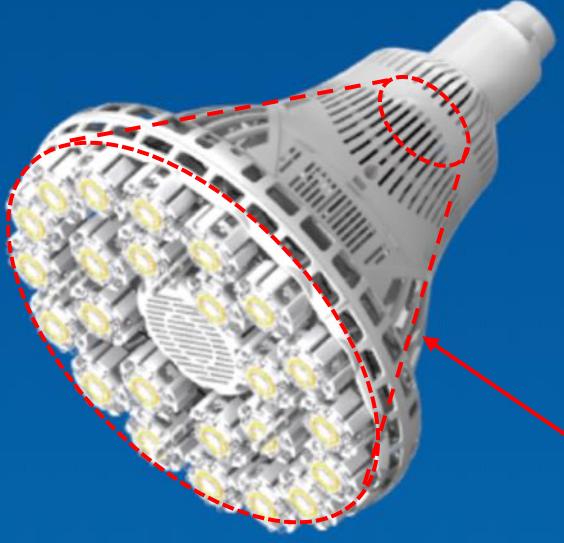
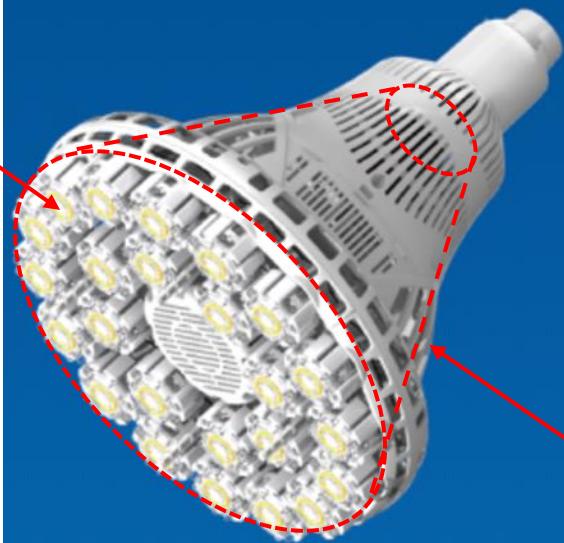
Claim 17	Analysis	Select Evidence
a first aperture;	Sansi C21BB-ZE39/E40 High Bay Light has a first aperture.	 <p>A photograph of a Sansi C21BB-ZE39/E40 High Bay Light bulb. The bulb is white with a textured, ribbed base. A red arrow points to the top edge of the bulb, where the LED array is housed, labeled "first aperture".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a second distal aperture,	Sansi C21BB-ZE39/E40 High Bay Light has a second distal aperture.	 <p>A photograph of the same Sansi C21BB-ZE39/E40 High Bay Light bulb from a slightly different angle. A red arrow points to the bottom edge of the bulb, where the LED array is housed, labeled "second distal aperture".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



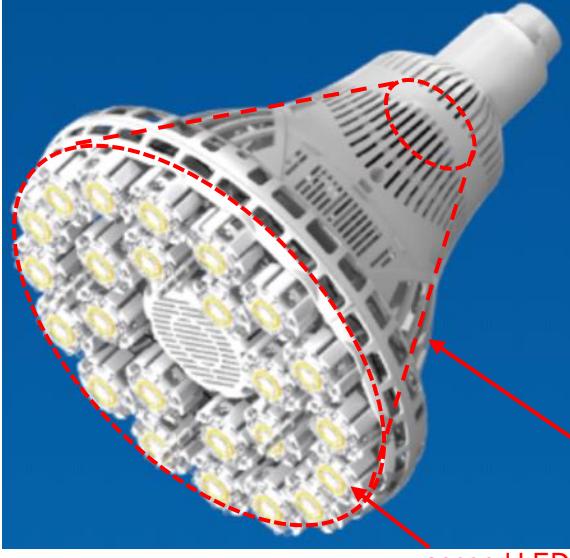
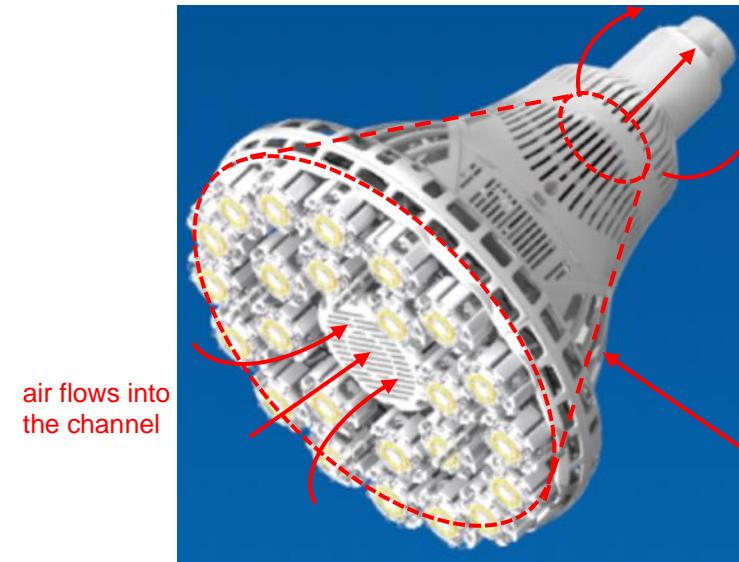
Claim 17	Analysis	Select Evidence
a channel through the member extending from the first aperture to the second aperture and defined by the interior surface of the member;	Sansi C21BB-ZE39/E40 High Bay Light has a channel through the member extending from the first aperture to the second aperture and defined by the interior surface of the member.	 <p data-bbox="1389 703 1727 727">concealed channel (inside)</p> <p data-bbox="804 809 1474 833">Source: http://www.sansi.com/products/highbay/305.htm</p>
at least one first light emitting diode (LED) coupled adjacent a first side of the channel;	Sansi C21BB-ZE39/E40 High Bay Light has at least one first light emitting diode (LED) coupled adjacent a first side of the channel.	 <p data-bbox="1543 1315 1881 1339">first LED</p> <p data-bbox="1543 1315 1881 1339">concealed channel (inside)</p> <p data-bbox="804 1413 1474 1437">Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



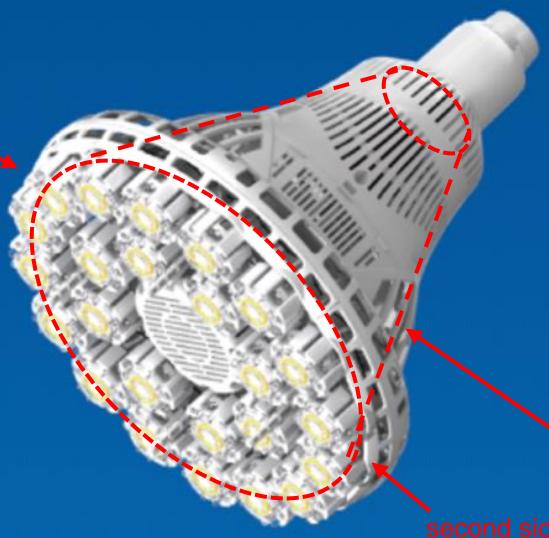
Claim 17	Analysis	Select Evidence
at least one second LED coupled adjacent a second side of the channel;	Sansi C21BB-ZE39/E40 High Bay Light has at least one second LED coupled adjacent a second side of the channel.	 <p>The image shows a side view of the Sansi C21BB-ZE39/E40 High Bay Light. A second LED is highlighted with a red dashed circle and labeled "second LED". Another red dashed circle highlights a "concealed channel (inside)" on the side of the light fixture.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	The air enters the channel of Sansi C21BB-ZE39/E40 High Bay Light and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	 <p>The image shows a side view of the Sansi C21BB-ZE39/E40 High Bay Light. Red arrows indicate air flowing into the "concealed channel (inside)" from the bottom left and air flowing out of the channel from the top right. The channel is highlighted with red dashed circles.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

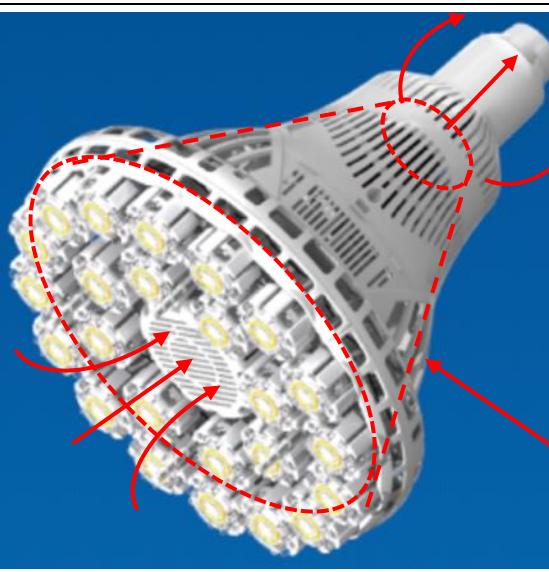
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 18	Analysis	Select Evidence
The light fixture of claim 17, wherein the second side of the channel is opposite the first side of the channel.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the second side of the channel is opposite the first side of the channel.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Claim 19	Analysis	Select Evidence
The light fixture of claim 17, wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



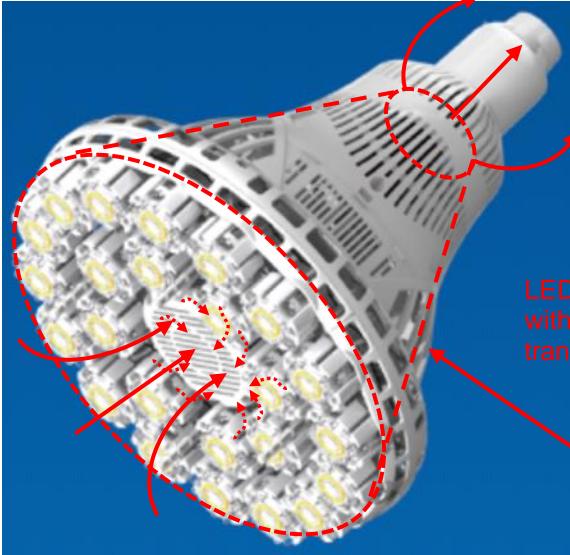
Claim 20	Analysis	Select Evidence
<p>The light fixture of claim 17, wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.</p>	 <p>A photograph of a Sansi C21BB-ZE39/E40 High Bay Light fixture. The fixture has a cylindrical metal housing with a grid of yellow LEDs on the front. Red dashed circles highlight specific areas: one on the left side labeled "air flows into the channel" and another on the top right labeled "air flows out of the channel". Red arrows point from these labels to the respective dashed circles. Another red arrow points from a label "concealed channel (inside)" to the interior of the fixture's housing. A label "LEDs are in thermal communication with the member and configured to transfer heat by convection" points to the area around the LEDs.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

EXHIBIT 7

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



U.S. Patent No. 8,256,923: Sansi C21BB-WE Omni-directional Light Bulb¹

Claim 1	Analysis	Select Evidence
A light fixture, comprising: a member comprising: a top end comprising a first aperture;	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a member comprising a top end comprising a first aperture.	 Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901

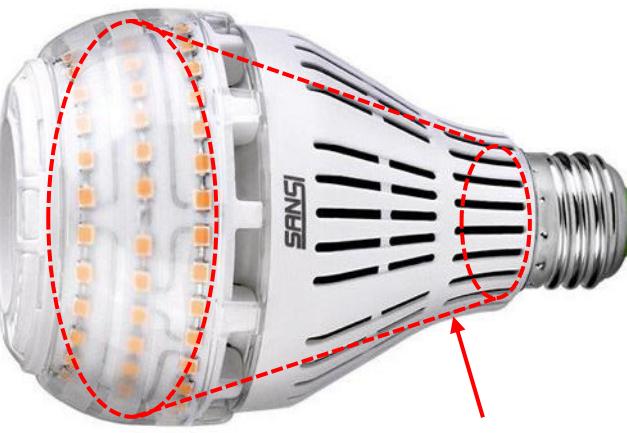
¹ Although this claim chart uses Sansi C21BB-WE Omni-directional Light Bulb as an example, other products in the same family infringe this patent in the same way. Those products include, at least, Sansi C21BB-TE26 UV Light Bulb, Sansi C21BB-QE Smart RGB Light Bulb, Sansi C21BB-TE26/27 Plain Light Bulb, Sansi C21BB-RE Dimmable Light Bulb, and Sansi C21BB-UE Light Bulb.

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



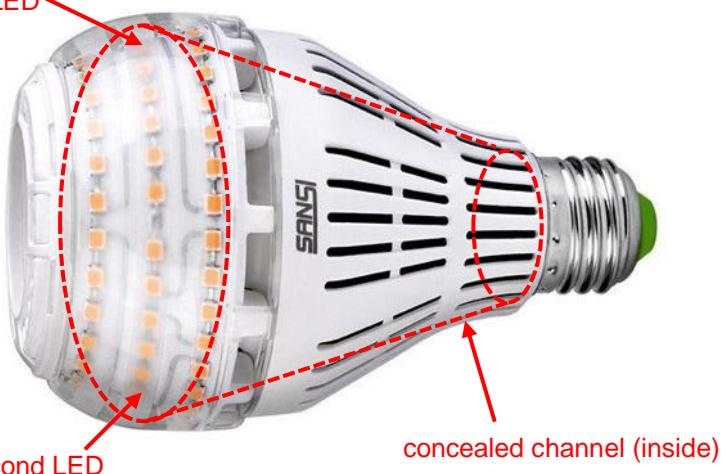
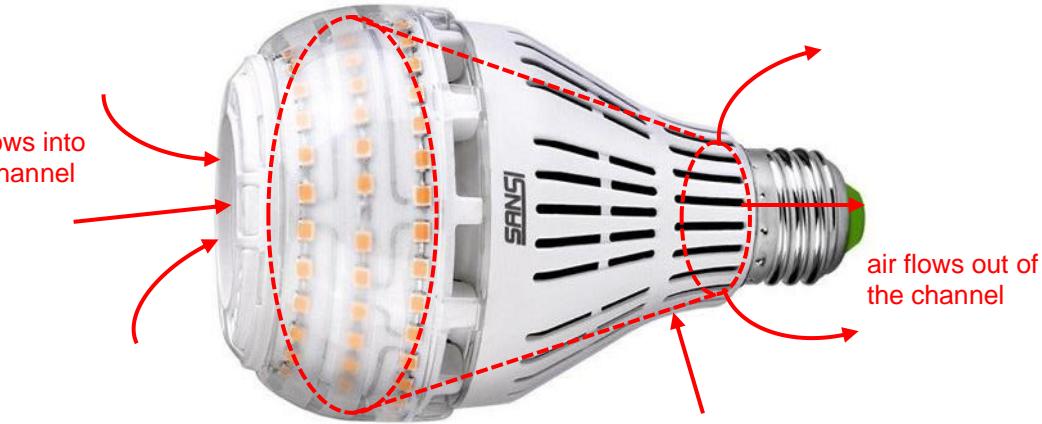
Claim 1	Analysis	Select Evidence
a bottom end comprising a second aperture,	Sansi C21BB-WE Omni-directional Light Bulb has a bottom end comprising a second aperture.	 <p data-bbox="802 799 1921 848">Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a channel extending from the first aperture to the second aperture and defined by an interior surface of the member;	Sansi C21BB-WE Omni-directional Light Bulb has a channel extending from the first aperture to the second aperture and defined by an interior surface of the member.	 <p data-bbox="802 1403 1921 1452">Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 1	Analysis	Select Evidence
a plurality of light emitting diodes (LEDs) disposed on the fixture adjacent to the channel, wherein at least one LED is located on one side of the channel and at least another LED is located on an opposite side of the channel;	Sansi C21BB-WE Omni-directional Light Bulb has a plurality of light emitting diodes (LEDs) disposed on the fixture adjacent to the channel, wherein at least one LED is located on one side of the channel and at least another LED is located on an opposite side of the channel.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
wherein air enters the channel through the second aperture and exits the channel through the first aperture; and	The air enters the channels of Sansi C21BB-WE Omni-directional Light Bulb through the second aperture and exits the channel through the first aperture.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 1	Analysis	Select Evidence
wherein the LEDs transfer heat through the member to the air in the channel.	The LEDs on Sansi C21BB-WE Omni-directional Light Bulb transfer heat through the member to the air in the channel.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Claim 3	Analysis	Select Evidence
The light fixture of claim 1, further comprising a plurality of LED receiving surfaces, wherein the LED receiving surfaces are disposed at least partially around the channel.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a plurality of LED receiving surfaces, wherein the LED receiving surfaces are disposed at least partially around the channel.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 4	Analysis	Select Evidence
<p>The light fixture of claim 1, further comprising a mounting member extending outwardly in a direction substantially orthogonal to a longitudinal axis of the channel.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a mounting member extending outwardly in a direction substantially orthogonal to a longitudinal axis of the channel.</p>	 <p>A photograph of a Sansi C21BB-WE LED light bulb. A red dashed circle highlights the LED chip area at the top, and a red arrow points to the green base labeled "mounting member". Another red arrow points to the text "longitudinal axis of the channel" pointing towards the central tube.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
<p>The light fixture of claim 1, further comprising an optically transmissive cover disposed at least partially around the member.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising an optically transmissive cover disposed at least partially around the member.</p>	 <p>A photograph of a Sansi C21BB-WE LED light bulb. Two red circles highlight the clear plastic cover. A red arrow points to the text "optically transmissive cover" pointing towards the top cover.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 12	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an interior surface;	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a member comprising an interior surface.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
an exterior surface;	Sansi C21BB-WE Omni-directional Light Bulb has an exterior surface.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



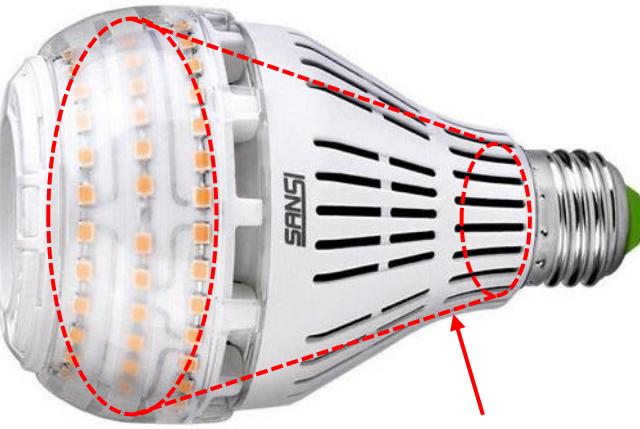
Claim 12	Analysis	Select Evidence
a first aperture disposed along a first end;	Sansi C21BB-WE Omni-directional Light Bulb has a first aperture disposed along a first end.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a second aperture disposed along a distal second end;	Sansi C21BB-WE Omni-directional Light Bulb has a second aperture disposed along a distal second end.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 12	Analysis	Select Evidence
a channel extending from the first aperture to the second aperture and defined by the interior surface; and	Sansi C21BB-WE Omni-directional Light Bulb has a channel extending from the first aperture to the second aperture and defined by the interior surface.	 <p>A photograph of a SANSI C21BB-WE LED light bulb. A red dashed circle highlights a section of the bulb's body, specifically the area between two apertures. An arrow points from the text "concealed channel (inside)" to this highlighted area, indicating that the channel is defined by the interior surface of the bulb's body.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a plurality of light emitting diodes (LEDs) positioned adjacent to the channel; wherein a first of the plurality of LEDs is disposed adjacent a first portion of the channel and a second of the plurality of LEDs is disposed adjacent a second portion of the channel different than the first portion; and	Sansi C21BB-WE Omni-directional Light Bulb has a plurality of light emitting diodes (LEDs) positioned adjacent to the channel; wherein a first of the plurality of LEDs is disposed adjacent a first portion of the channel and a second of the plurality of LEDs is disposed adjacent a second portion of the channel different than the first portion.	 <p>A photograph of the same SANSI C21BB-WE LED light bulb, showing a different angle. Red dashed circles highlight two specific LEDs: "first LED" at the top left and "second LED" at the bottom left. Another red dashed circle highlights the "concealed channel (inside)" between two apertures on the right side of the bulb. Arrows point from the text labels to their respective features in the image.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 12	Analysis	Select Evidence
<p>wherein air passes through the channel from the second aperture to the first aperture and transfers at least a portion of heat generated by the first LED and the second LED through the first aperture.</p>	<p>The air passes through the channel of Sansi C21BB-WE Omni-directional Light Bulb from the second aperture to the first aperture and transfers at least a portion of heat generated by the first LED and the second LED through the first aperture.</p>	<p>A photograph of the Sansi C21BB-WE light bulb with various parts labeled with red arrows and text. A dashed red circle highlights the area around the second aperture (top) and the first aperture (bottom). Red arrows point from the left and right towards this circle, labeled "air flows into the channel". Another red arrow points away from the top, labeled "air flows out of the channel". A label "concealed channel (inside)" points to the internal structure of the bulb. The word "SANSI" is printed on the side of the bulb.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

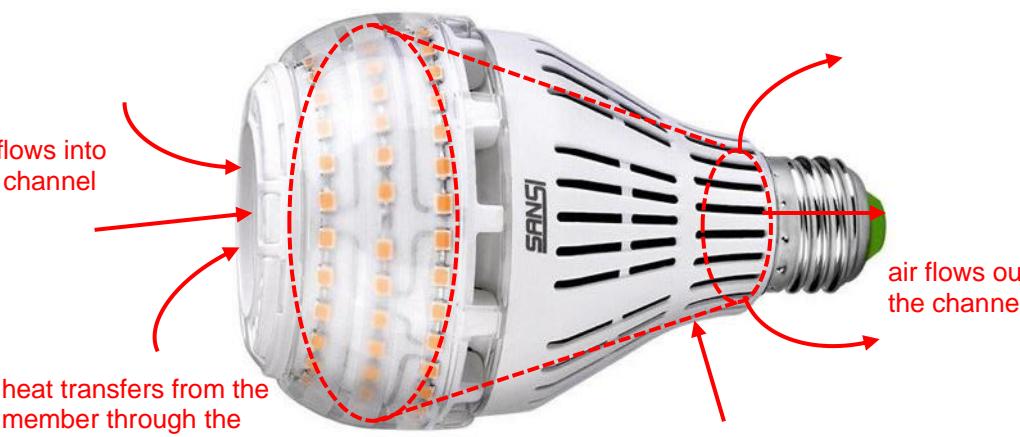
Claim 14	Analysis	Select Evidence
<p>The light fixture of claim 12, further comprising a mounting member extending outwardly from the member in a direction away from a longitudinal axis of the channel.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a mounting member extending outwardly from the member in a direction away from a longitudinal axis of the channel.</p>	<p>A photograph of the Sansi C21BB-WE light bulb with specific parts labeled with red arrows and text. A dashed red circle highlights the area around the second aperture (top). A red arrow points to the left, labeled "longitudinal axis of the channel". A red box highlights the E26 base, with a red arrow pointing to it labeled "mounting member". The word "SANSI" is printed on the side of the bulb.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 15	Analysis	Select Evidence
The light fixture of claim 12, wherein the heat is transferred from the first and second LED to the member by conduction; and	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the heat is transferred from the first and second LED to the member by conduction.	 <p>heat transfer into the channel</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
wherein the heat is transferred from the member through the channel with the air by convection.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the heat is transferred from the member through the channel with the air by convection.	 <p>air flows into the channel</p> <p>heat transfers from the member through the channel by convection</p> <p>concealed channel (inside)</p> <p>air flows out of the channel</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 17	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an interior surface	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture, comprising a member comprising an interior surface.	<p>interior surface (concealed)</p>
a first aperture;	Sansi C21BB-WE Omni-directional Light Bulb has a first aperture.	<p>first aperture</p>

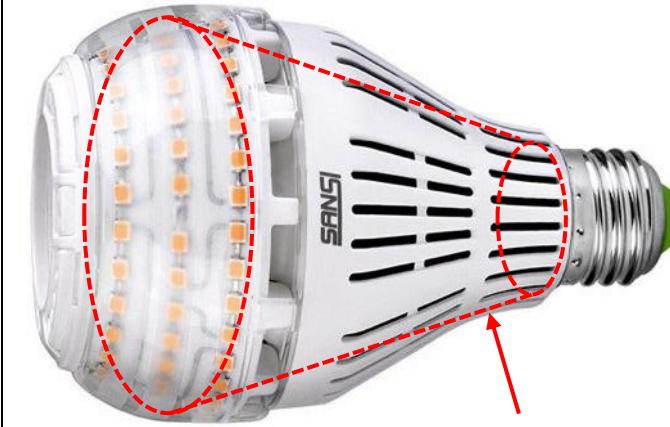
Source: <https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



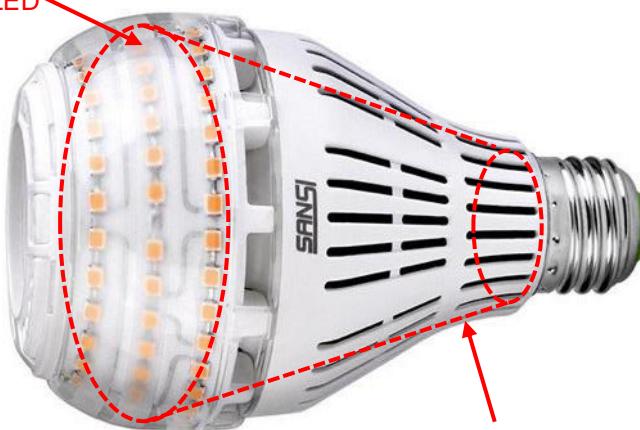
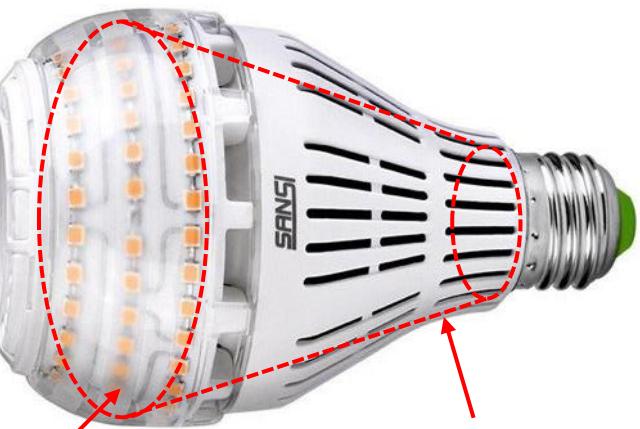
Claim 17	Analysis	Select Evidence
a second distal aperture,	Sansi C21BB-WE Omni-directional Light Bulb has a second distal aperture.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a channel through the member extending from the first aperture to the second aperture and defined by the interior surface of the member;	Sansi C21BB-WE Omni-directional Light Bulb has a channel through the member extending from the first aperture to the second aperture and defined by the interior surface of the member.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



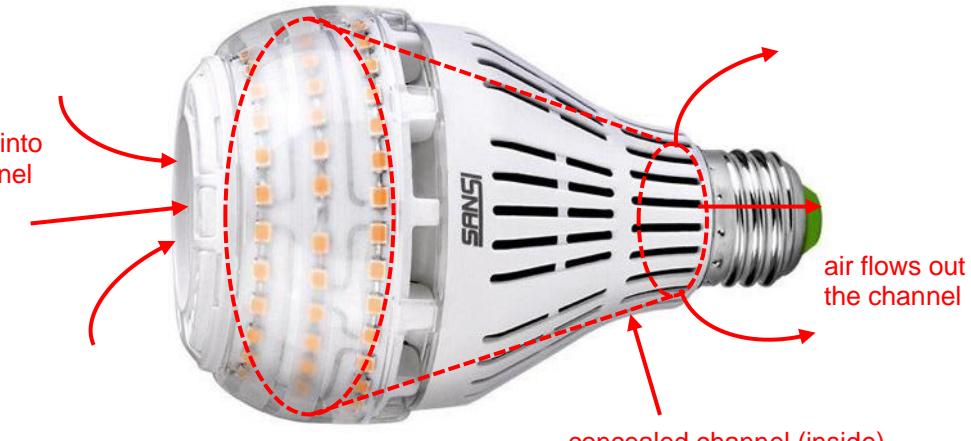
Claim 17	Analysis	Select Evidence
at least one first light emitting diode (LED) coupled adjacent a first side of the channel;	Sansi C21BB-WE Omni-directional Light Bulb has at least one first light emitting diode (LED) coupled adjacent a first side of the channel.	 <p>A photograph of a Sansi C21BB-WE Omni-directional Light Bulb. A red dashed circle highlights the left side of the bulb, labeled "first LED". Another red dashed circle highlights the right side, labeled "concealed channel (inside)". The bulb is clear with black fins and a green base.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
at least one second LED coupled adjacent a second side of the channel;	Sansi C21BB-WE Omni-directional Light Bulb has at least one second LED coupled adjacent a second side of the channel.	 <p>A photograph of a Sansi C21BB-WE Omni-directional Light Bulb. A red dashed circle highlights the right side of the bulb, labeled "second LED". Another red dashed circle highlights the left side, labeled "concealed channel (inside)". The bulb is clear with black fins and a green base.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

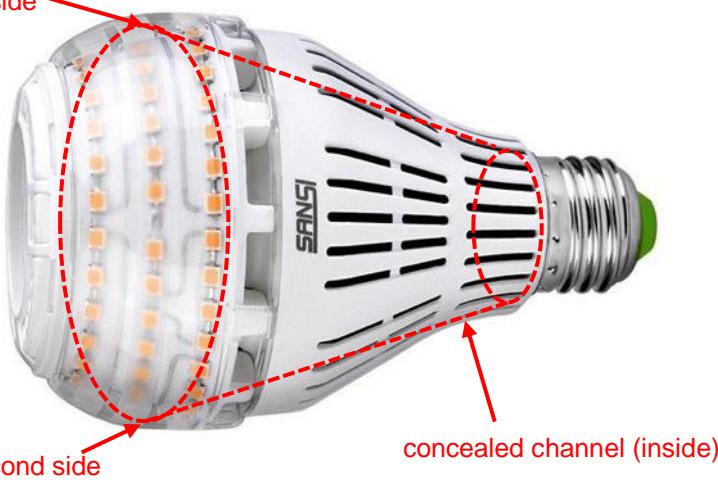
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 17	Analysis	Select Evidence
wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	The air enters the channel of Sansi C21BB-WE Omni-directional Light Bulb and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	 <p>A diagram of a Sansi C21BB-WE LED light bulb. A central vertical channel is shown with a dashed red outline. Red arrows indicate air flowing into the channel from the left and out of the channel from the right. The word "concealed channel (inside)" is written below the bulb. The bulb has a green base and a silver screw-on cap.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Claim 18	Analysis	Select Evidence
The light fixture of claim 17, wherein the second side of the channel is opposite the first side of the channel.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the second side of the channel is opposite the first side of the channel.	 <p>A diagram of a Sansi C21BB-WE LED light bulb. Two sides of a central vertical channel are highlighted with dashed red outlines. The left side is labeled "first side" and the right side is labeled "second side". The word "concealed channel (inside)" is written below the bulb. The bulb has a green base and a silver screw-on cap.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 19	Analysis	Select Evidence
<p>The light fixture of claim 17, wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.</p>	 <p>A diagram of the SANSI C21BB-WE LED light bulb. The bulb is shown from a side-on perspective, revealing its internal structure. A central column of orange LED chips is visible. Red dashed lines form a vertical channel around these LEDs. Arrows indicate air flowing into this channel from the left and air exiting from the right, labeled "air flows into the channel" and "air flows out of the channel (venturi effect)". The word "concealed channel (inside)" points to the channel itself. The brand name "SANSI" is printed on the side of the bulb.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

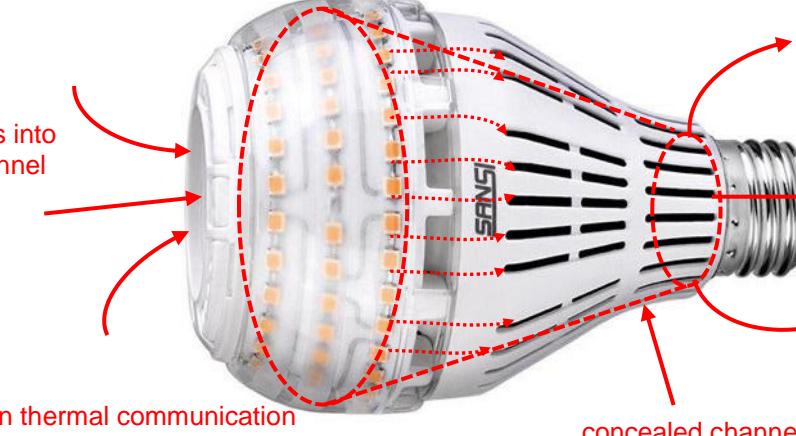
Claim 20	Analysis	Select Evidence
<p>The light fixture of claim 17, wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.</p>	 <p>A diagram of the SANSI C21BB-WE LED light bulb, similar to the one above but with additional annotations. Red dashed lines outline the central channel around the LED array. Arrows show air entering from the left and exiting from the right, labeled "air flows into the channel" and "air flows out of the channel". The word "concealed channel (inside)" points to the channel. A new annotation at the bottom left states "LEDs are in thermal communication with the member and configured to transfer heat by convection".</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

EXHIBIT 8

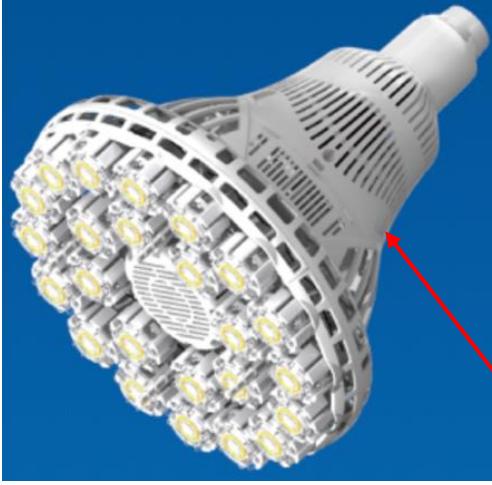
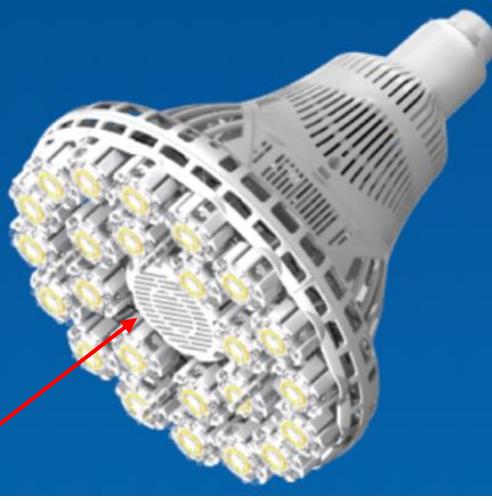
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



U.S. Patent No. 9,163,807: Sansi C21BB-ZE39/E40 High Bay Light¹

Claim 14	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an exterior surface;	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a member comprising an exterior surface.	 <p>A photograph of a Sansi C21BB-ZE39/E40 High Bay Light bulb. The bulb has a white, ribbed exterior housing. A red arrow points from the text "exterior surface" to the side of the bulb where the ribbed texture is most prominent.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
an interior surface;	Sansi C21BB-ZE39/E40 High Bay Light has an interior surface.	 <p>A photograph of the same Sansi C21BB-ZE39/E40 High Bay Light bulb, shown from a slightly different angle. A red arrow points from the text "interior surface (concealed)" to the side of the bulb where the ribbed texture is less visible, indicating the concealed interior surface.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

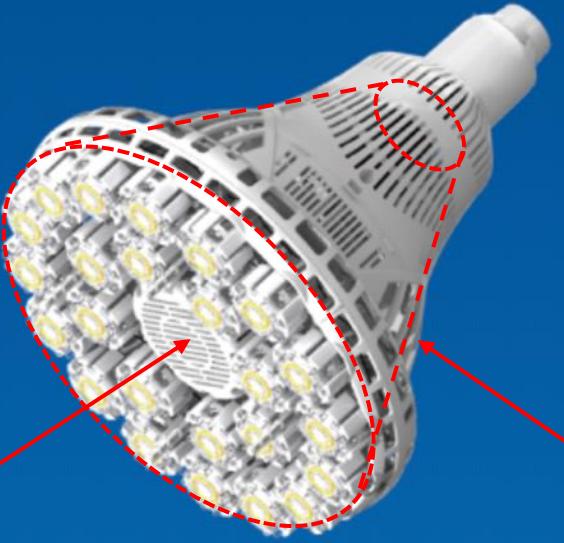
¹ Although this claim chart uses Sansi C21BB-ZE39/E40 High Bay Light as an example, other products in the same family infringe this patent in the same way. Those products include, at least, Sansi C21GL-CE26/27 Full Spectrum Glow Light and BR30 Non-Dimmable LED Light Bulb.

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



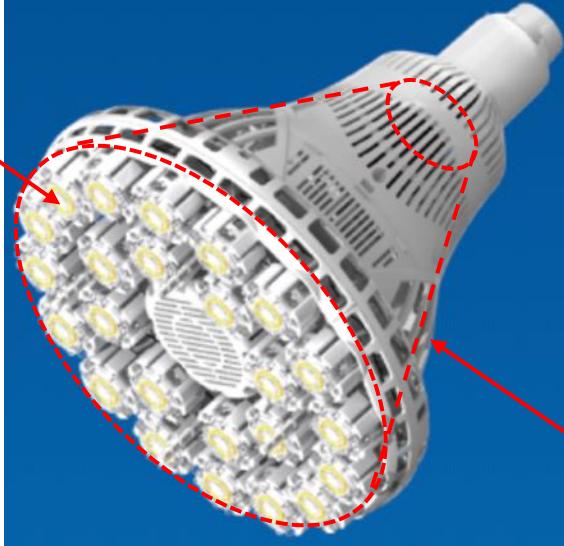
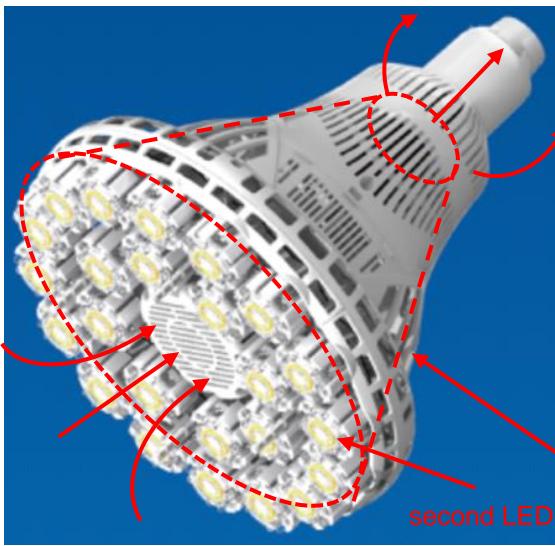
Claim 14	Analysis	Select Evidence
a first aperture disposed along a top end of the member;	Sansi C21BB-ZE39/E40 High Bay Light has a first aperture disposed along a top end of the member.	 <p data-bbox="1368 241 2031 784">first aperture</p> <p data-bbox="804 784 1368 817">Source: http://www.sansi.com/products/highbay/305.htm</p>
a second aperture disposed along a bottom end of the member, and a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface;	Sansi C21BB-ZE39/E40 High Bay Light has a second aperture disposed along a bottom end of the member, and a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface.	 <p data-bbox="1030 1372 2031 1455">second aperture</p> <p data-bbox="1594 1372 2031 1455">concealed channel (inside)</p> <p data-bbox="804 1372 1368 1455">Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



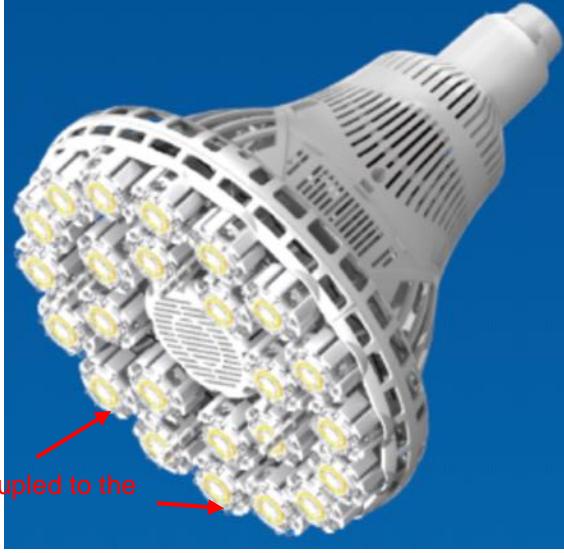
Claim 14	Analysis	Select Evidence
at least one first light emitting diode (LED) coupled to a first facet of the exterior surface; and	Sansi C21BB-ZE39/E40 High Bay Light has at least one first light emitting diode (LED) coupled to a first facet of the exterior surface.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
at least one second LED coupled to a second facet of the exterior surface, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	Sansi C21BB-ZE39/E40 High Bay Light has at least one second LED coupled to a second facet of the exterior surface, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

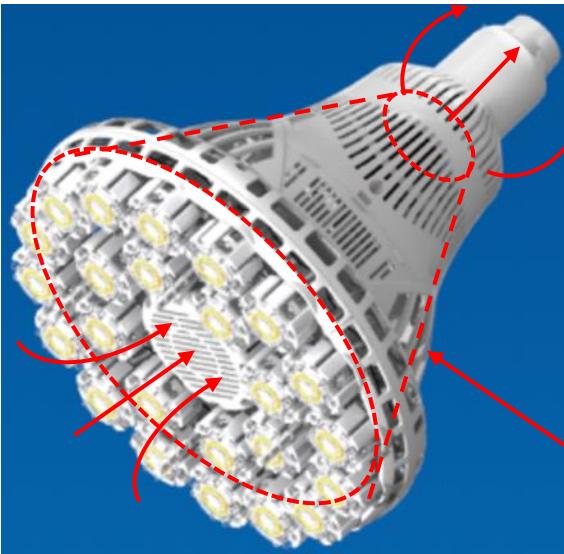
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 15	Analysis	Select Evidence
The light fixture of claim 14, wherein the first and second LEDs are removably coupled to the exterior surface.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the first and second LEDs are removably coupled to the exterior surface.	 <p data-bbox="819 703 1241 763">LEDs are removably coupled to the exterior surface</p> <p data-bbox="804 791 1465 816">Source: http://www.sansi.com/products/highbay/305.htm</p>

Claim 16	Analysis	Select Evidence
The light fixture of claim 14, wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.	 <p data-bbox="819 1274 973 1339">air flows into the channel</p> <p data-bbox="1543 1029 1761 1127">air flows out of the channel (by venturi effect)</p> <p data-bbox="1564 1372 1902 1405">concealed channel (inside)</p> <p data-bbox="804 1465 1465 1490">Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



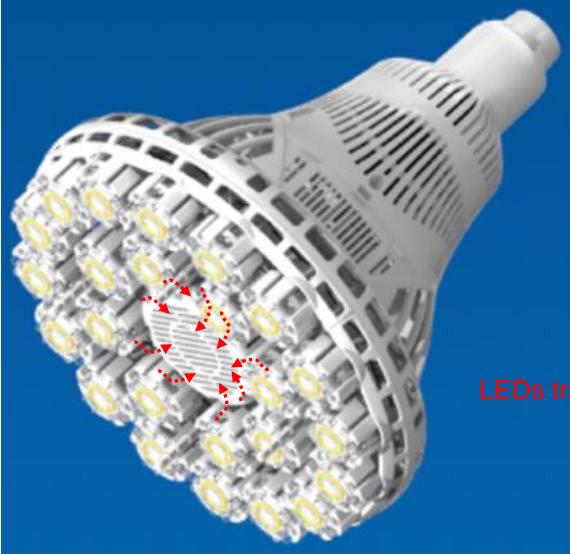
Claim 17	Analysis	Select Evidence
<p>The light fixture of claim 14, wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member.</p>	<div style="display: flex; align-items: center;">  <div style="margin-left: 20px;"> <p>LEDs transfer heat to the member</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p> </div> </div>

EXHIBIT 9

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



U.S. Patent No. 9,163,807: Sansi C21BB-WE Omni-directional Light Bulb¹

Claim 14	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an exterior surface;	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a member comprising an exterior surface.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
an interior surface;	Sansi C21BB-WE Omni-directional Light Bulb has an interior surface.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

¹ Although this claim chart uses Sansi C21BB-WE Omni-directional Light Bulb as an example, other products in the same family infringe this patent in the same way. Those products include, at least, Sansi C21BB-TE26 UV Light Bulb, Sansi C21BB-QE Smart RGB Light Bulb, Sansi C21BB-TE26/27 Plain Light Bulb, Sansi C21BB-RE Dimmable Light Bulb, and Sansi C21BB-UE Light Bulb.

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



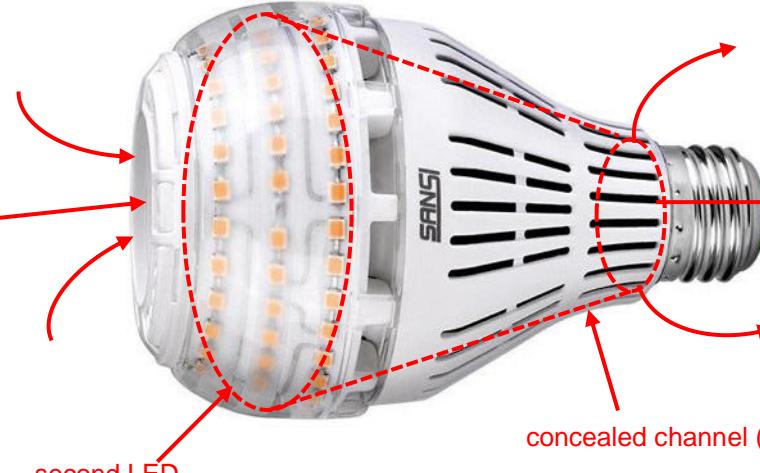
Claim 14	Analysis	Select Evidence
a first aperture disposed along a top end of the member;	Sansi C21BB-WE Omni-directional Light Bulb has a first aperture disposed along a top end of the member.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a second aperture disposed along a bottom end of the member, and a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface;	Sansi C21BB-WE Omni-directional Light Bulb has a second aperture disposed along a bottom end of the member, and a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 14	Analysis	Select Evidence
at least one first light emitting diode (LED) coupled to a first facet of the exterior surface; and	Sansi C21BB-WE Omni-directional Light Bulb has at least one first light emitting diode (LED) coupled to a first facet of the exterior surface.	 <p>The image shows a side view of a SANSI C21BB-WE LED light bulb. A dashed red circle highlights the area where the LED array is located on the left side of the bulb. Another dashed red circle highlights a 'concealed channel (inside)' on the right side of the bulb, near the base. Red arrows point from the text labels to their respective areas on the bulb.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
at least one second LED coupled to a second facet of the exterior surface, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	Sansi C21BB-WE Omni-directional Light Bulb has at least one second LED coupled to a second facet of the exterior surface, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	 <p>The diagram shows the same SANSI C21BB-WE LED light bulb as above, but with additional red arrows indicating air flow. Arrows point from the text labels to specific parts of the bulb: 'air flows into the channel' points to the left side where the LED array is located; 'air flows out of the channel' points to the right side near the base; and 'concealed channel (inside)' points to the area highlighted by the dashed red circle on the right. A red arrow also points to the 'second LED' on the left side.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 15	Analysis	Select Evidence
The light fixture of claim 14, wherein the first and second LEDs are removably coupled to the exterior surface.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the first and second LEDs are removably coupled to the exterior surface.	 <p data-bbox="819 719 1431 752">LEDs are removably coupled to the exterior surface</p> <p data-bbox="819 768 1917 817">Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Claim 16	Analysis	Select Evidence
The light fixture of claim 14, wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.	 <p data-bbox="819 1377 1917 1426">Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 17	Analysis	Select Evidence
The light fixture of claim 14, wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Claim 19	Analysis	Select Evidence
The light fixture of claim 14, wherein an optically transmissive cover is disposed about the first member.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein an optically transmissive cover is disposed about the first member.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

EXHIBIT 10

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



U.S. Patent No. 7,874,700: Sansi C21BB-WE Omni-directional Light Bulb¹

Claim 1	Analysis	Select Evidence
A light fixture, comprising: a member comprising: a first surface disposed along an interior of the member;	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a member comprising a first surface disposed along an interior of the member.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a second surface disposed along an exterior of the member;	Sansi C21BB-WE Omni-directional Light Bulb has a second surface disposed along an exterior of the member.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

¹ Although this claim chart uses Sansi C21BB-WE Omni-directional Light Bulb as an example, other products in the same family infringe this patent in the same way. Those products include, at least, Sansi C21BB-TE26 UV Light Bulb, Sansi C21BB-QE Smart RGB Light Bulb, Sansi C21BB-TE26/27 Plain Light Bulb, Sansi C21BB-RE Dimmable Light Bulb, and Sansi C21BB-UE Light Bulb.

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



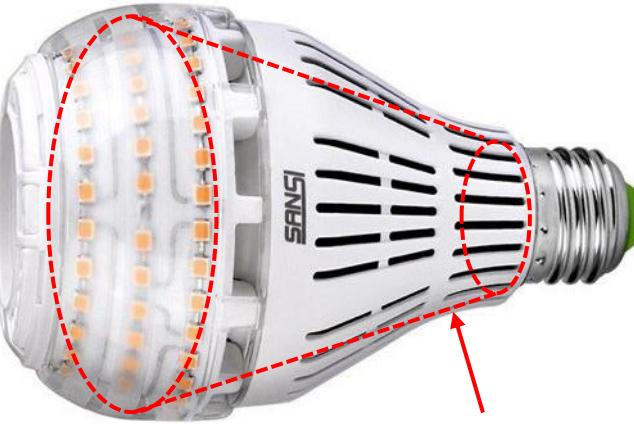
Claim 1	Analysis	Select Evidence
a first end comprising a first aperture;	Sansi C21BB-WE Omni-directional Light Bulb has a first end comprising a first aperture.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a second end comprising a second aperture;	Sansi C21BB-WE Omni-directional Light Bulb has a second end comprising a second aperture.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 1	Analysis	Select Evidence
a channel extending from the first aperture to the second aperture and defined by the first surface; and	Sansi C21BB-WE Omni-directional Light Bulb has a channel extending from the first aperture to the second aperture and it's defined by the interior surface.	 <p>concealed channel (inside)</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a plurality of receiving surfaces disposed at least partially around the channel, along the second surface of the member, each receiving surface being configured to receive at least one light emitting diode; and	Sansi C21BB-WE Omni-directional Light Bulb has a plurality of receiving surfaces disposed at least partially around the channel, along the second surface of the member, each receiving surface being configured to receive at least one light emitting diode	 <p>receiving surfaces</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



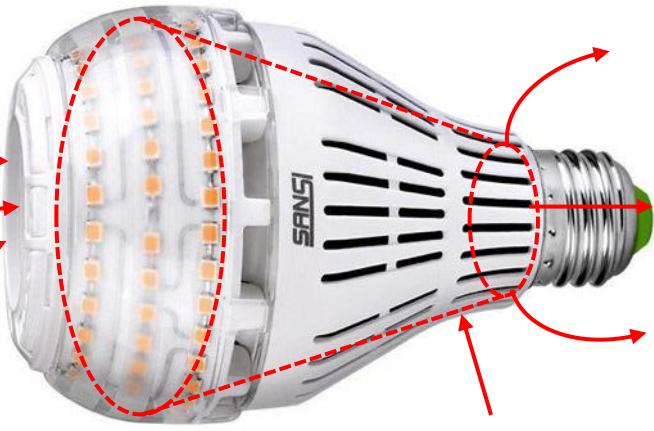
Claim 1	Analysis	Select Evidence
at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces,	Sansi C21BB-WE Omni-directional Light Bulb has at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces.	 <p data-bbox="819 719 1431 752">LEDs are removably coupled to the exterior surface</p> <p data-bbox="819 763 1917 817">Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
wherein the light emitting diodes transfer heat through conduction to the member; and	The light emitting diodes of Sansi C21BB-WE Omni-directional Light Bulb transfer heat through conduction to the member.	 <p data-bbox="819 948 1100 1034">heat transfer from the LEDs to the member by conduction</p> <p data-bbox="819 1383 1917 1437">Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

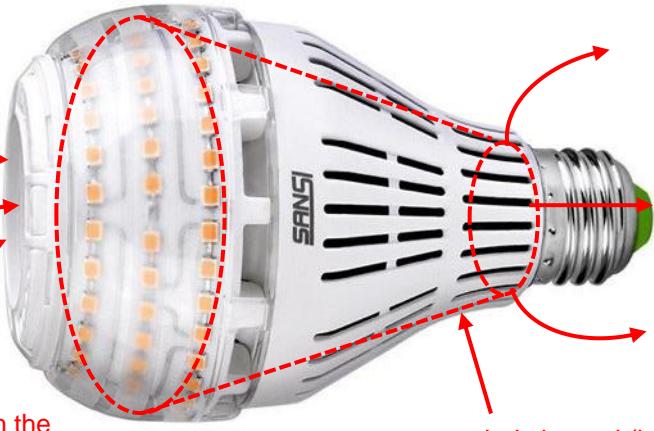
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 1	Analysis	Select Evidence
wherein air passes through the channel to transfer heat from member.	Air passes through the channel of Sansi C21BB-WE Omni-directional Light Bulb to transfer heat from member.	 <p>The diagram shows a cross-section of a light bulb. A central column of orange LED chips is visible. A dashed red circle highlights a 'concealed channel (inside)' running vertically through the bulb. Red arrows indicate air flowing into the channel from the left and out of the channel from the right. The word 'SANSI' is printed on the side of the bulb.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

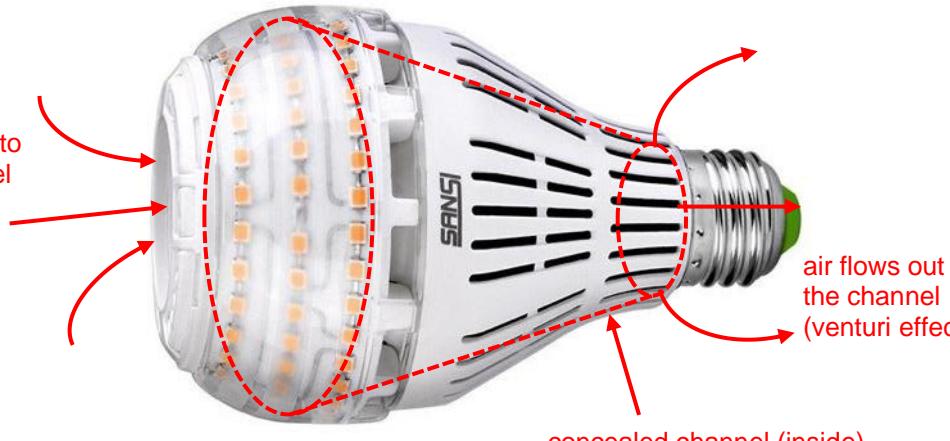
Claim 2	Analysis	Select Evidence
The light fixture of claim 1, wherein the heat is transferred from the member through the channel by convection.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the heat is transferred from the member through the channel by convection.s	 <p>The diagram is identical to the one in Claim 1, showing air flowing through a concealed channel. An additional annotation in red text at the bottom center states: 'heat transfers from the member through the channel by convection'.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 3	Analysis	Select Evidence
The light fixture of claim 1, wherein the channel is configured to transfer the heat from the member by a venturi effect.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the channel is configured to transfer the heat from the member by a venturi effect.	 <p>The diagram shows a cross-section of the SANSI C21BB-WE LED light bulb. A central vertical channel is highlighted with a dashed red circle. Red arrows indicate air flowing into the channel from the left and out of the channel from the right, demonstrating the venturi effect. The word "concealed channel (inside)" is written below the bulb's body.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Claim 13	Analysis	Select Evidence
The light fixture of claim 1, wherein each light emitting diode is removably coupled to its respective receiving surface via a substrate that is in thermal contact with the receiving surface.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein each light emitting diode is removably coupled to its respective receiving surface via a substrate that is in thermal contact with the receiving surface.	 <p>The diagram shows a side view of the SANSI C21BB-WE LED light bulb. Three red arrows point to the LED chip assembly on the left, with the text "LEDs are removably coupled to the exterior surface" written below.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 16	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an interior surface;	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a member comprising an interior surface.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
an exterior surface;	Sansi C21BB-WE Omni-directional Light Bulb has an exterior surface.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



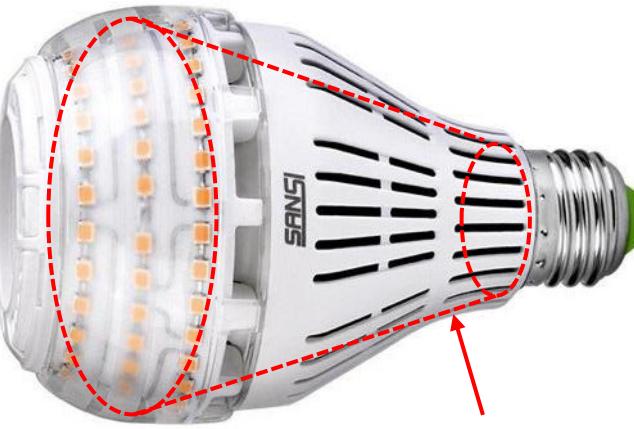
Claim 16	Analysis	Select Evidence
a first aperture disposed along a top end;	Sansi C21BB-WE Omni-directional Light Bulb has a first aperture disposed along a top end.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
second aperture disposed along a second end;	Sansi C21BB-WE Omni-directional Light Bulb has a second aperture disposed along a second end.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 16	Analysis	Select Evidence
a channel extending from the first aperture to the second aperture and defined by the interior surface; and	Sansi C21BB-WE Omni-directional Light Bulb has a channel extending from the first aperture to the second aperture and defined by the interior surface.	 <p>concealed channel (inside)</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a plurality of receiving surfaces disposed at least partially along the exterior surface, each receiving surface configured to receive at least one light emitting diode; and	Sansi C21BB-WE Omni-directional Light Bulb has a plurality of receiving surfaces disposed at least partially along the exterior surface, each receiving surface configured to receive at least one light emitting diode.	 <p>receiving surfaces</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



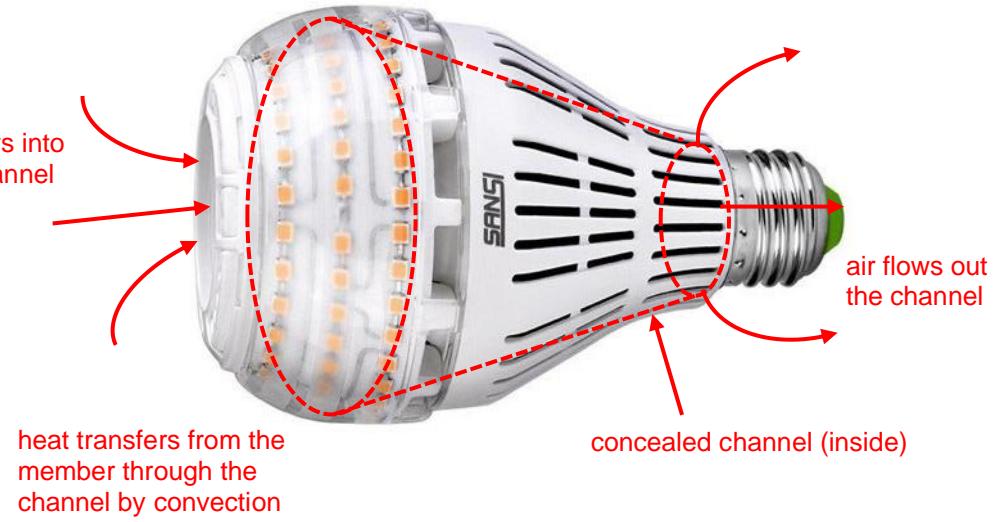
Claim 16	Analysis	Select Evidence
at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces,	Sansi C21BB-WE Omni-directional Light Bulb has at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces.	 <p data-bbox="819 731 1453 758">LEDs are removably coupled to the exterior surface</p> <p data-bbox="819 771 1917 829">Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
wherein the channel transfers at least a portion of heat generated by the light emitting diode through the first aperture.	Sansi C21BB-WE Omni-directional Light Bulb has a channel that transfers at least a portion of heat generated by the light emitting diode through the first aperture.	 <p data-bbox="819 975 988 1033">air flows into the channel</p> <p data-bbox="1748 1098 1917 1155">air flows out of the channel</p> <p data-bbox="1495 1269 1812 1297">concealed channel (inside)</p> <p data-bbox="819 1343 1917 1400">Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

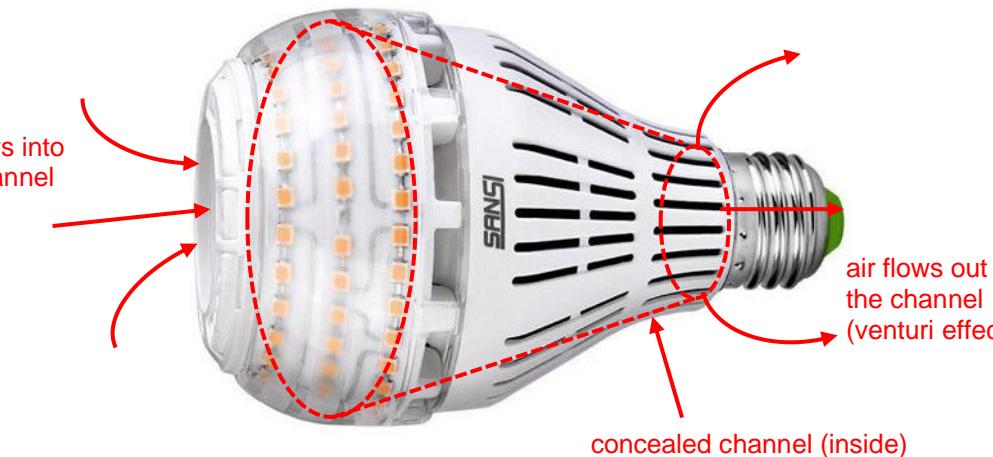
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 17	Analysis	Select Evidence
The light fixture of claim 16, wherein the heat is transferred from the member through the channel by convection.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the heat is transferred from the member through the channel by convection.	 <p>The diagram illustrates the internal structure of the Sansi C21BB-WE LED light bulb. A central column of orange LED chips is surrounded by a 'concealed channel (inside)'. Air flows into this channel from the left, as indicated by arrows, and then exits through the right side of the bulb. Red dashed circles highlight the flow paths. Text at the bottom center states: 'heat transfers from the member through the channel by convection'.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Claim 18	Analysis	Select Evidence
The light fixture of claim 16, wherein the heat is transferred from the member through the channel by a venturi effect.	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the heat is transferred from the member through the channel by a venturi effect.	 <p>The diagram illustrates the internal structure of the Sansi C21BB-WE LED light bulb, similar to the previous diagram but with a focus on the venturi effect. Air flows into the 'concealed channel (inside)' from the left, creating a low-pressure area that draws air out through the right side, as indicated by arrows. Red dashed circles highlight the flow paths. Text at the bottom center states: 'air flows out of the channel (venturi effect)'.</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 21	Analysis	Select Evidence
<p>The light fixture of claim 16, wherein each light emitting diode is removably coupled to its corresponding receiving surface via a substrate that is in thermal contact with the receiving surface.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein each light emitting diode is removably coupled to its corresponding receiving surface via a substrate that is in thermal contact with the receiving surface.</p>	 <p>A photograph of a SANSI C21BB-WE LED light bulb. The bulb has a clear plastic housing with a ribbed base. The brand name "SANSI" is printed vertically on the side. The interior is visible through the glass, showing a dense array of small orange LED chips mounted on a substrate. Three red arrows point from the text below to the LED array area. The text "LEDs are removably coupled to the exterior surface" is overlaid in red at the bottom of the image.</p> <p>LEDs are removably coupled to the exterior surface</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

EXHIBIT 11

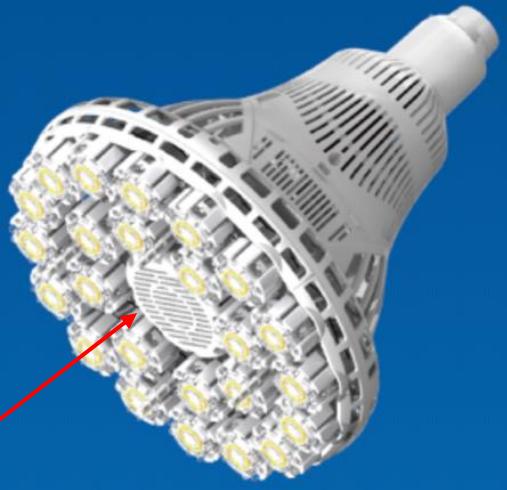
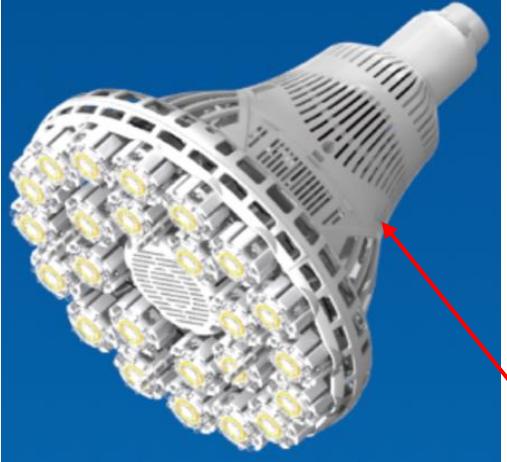
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



U.S. Patent No. 7,874,700: Sansi C21BB-ZE39/E40 High Bay Light¹

Claim 1	Analysis	Select Evidence
A light fixture, comprising: a member comprising: a first surface disposed along an interior of the member;	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a member comprising a first surface disposed along an interior of the member.	 <p>A photograph of the Sansi C21BB-ZE39/E40 High Bay Light bulb. The bulb has a white plastic housing with a textured pattern. The top part shows a cluster of yellow LED chips mounted on a printed circuit board. A red arrow points from the text "interior surface (concealed)" to the back of the LED array, which is hidden within the housing.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a second surface disposed along an exterior of the member;	Sansi C21BB-ZE39/E40 High Bay Light has a second surface disposed along an exterior of the member.	 <p>A photograph of the Sansi C21BB-ZE39/E40 High Bay Light bulb, similar to the one above but shown from a different angle. The red arrow points from the text "exterior surface" to the front face of the bulb, where the yellow LED array is visible through the clear glass or plastic lens.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

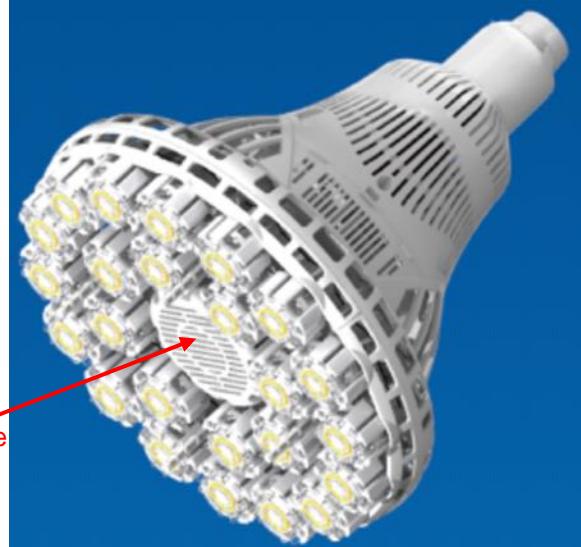
¹ Although this claim chart uses Sansi C21BB-ZE39/E40 High Bay Light as an example, other products in the same family infringe this patent in the same way. Those products include, at least, Sansi C21GL-CE26/27 Full Spectrum Glow Light and BR30 Non-Dimmable LED Light Bulb.

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



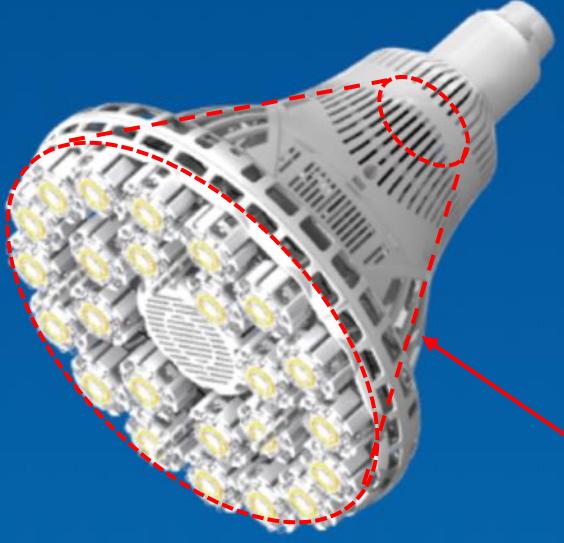
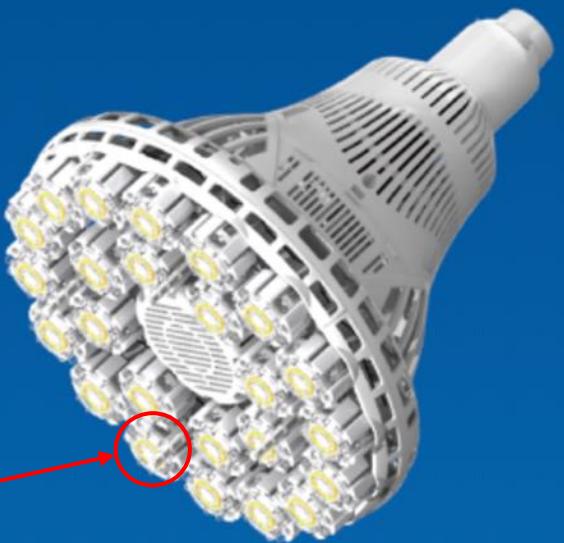
Claim 1	Analysis	Select Evidence
a first end comprising a first aperture;	Sansi C21BB-ZE39/E40 High Bay Light has a first end comprising a first aperture.	 <p>A photograph of a white, cylindrical LED high bay light bulb. The top portion, labeled as the 'first end', features a circular array of yellow LED chips and a metal heat sink. A red arrow points to this array with the label 'first aperture'.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a second end comprising a second aperture;	Sansi C21BB-ZE39/E40 High Bay Light has a second end comprising a second aperture.	 <p>A photograph of the same white, cylindrical LED high bay light bulb, viewed from the opposite end. The bottom portion, labeled as the 'second end', also features a circular array of yellow LED chips and a metal heat sink. A red arrow points to this array with the label 'second aperture'.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



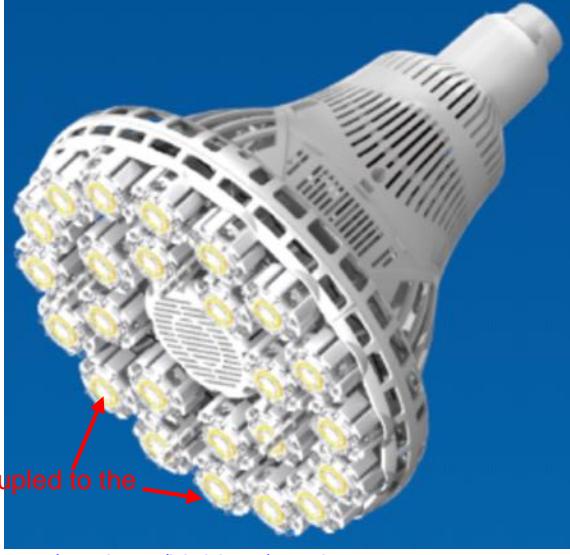
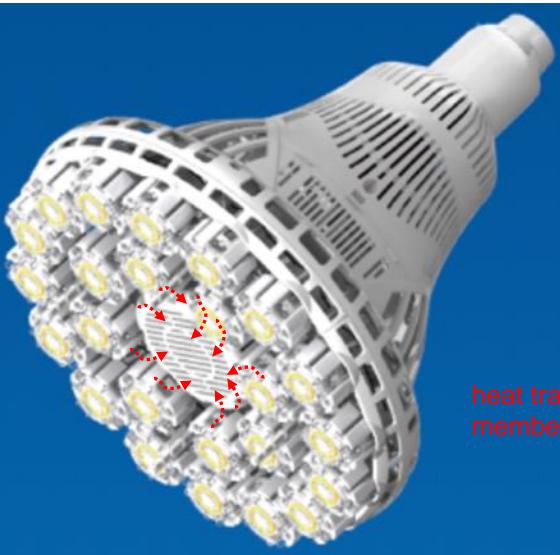
Claim 1	Analysis	Select Evidence
a channel extending from the first aperture to the second aperture and defined by the first surface; and	Sansi C21BB-ZE39/E40 High Bay Light has a channel extending from the first aperture to the second aperture and it's defined by the interior surface.	 <p data-bbox="1389 703 1727 727">concealed channel (inside)</p> <p data-bbox="804 809 1474 833">Source: http://www.sansi.com/products/highbay/305.htm</p>
a plurality of receiving surfaces disposed at least partially around the channel, along the second surface of the member, each receiving surface being configured to receive at least one light emitting diode; and	Sansi C21BB-ZE39/E40 High Bay Light has a plurality of receiving surfaces disposed at least partially around the channel, along the second surface of the member, each receiving surface being configured to receive at least one light emitting diode	 <p data-bbox="825 1323 1036 1348">receiving surfaces</p> <p data-bbox="804 1429 1474 1454">Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



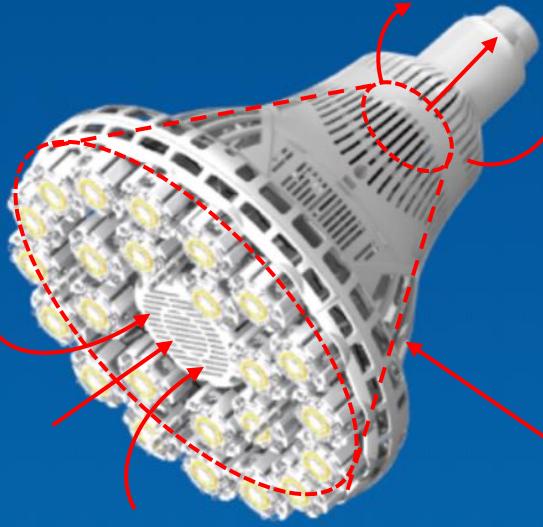
Claim 1	Analysis	Select Evidence
at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces,	Sansi C21BB-ZE39/E40 High Bay Light has at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces.	 <p data-bbox="819 703 1290 752">LEDs are removably coupled to the exterior surface</p> <p data-bbox="804 793 1465 817">Source: http://www.sansi.com/products/highbay/305.htm</p>
wherein the light emitting diodes transfer heat through conduction to the member; and	The light emitting diodes of Sansi C21BB-ZE39/E40 High Bay Light transfer heat through conduction to the member.	 <p data-bbox="1269 1225 1685 1290">heat transfer from the LEDs to the member by conduction</p> <p data-bbox="804 1445 1465 1470">Source: http://www.sansi.com/products/highbay/305.htm</p>

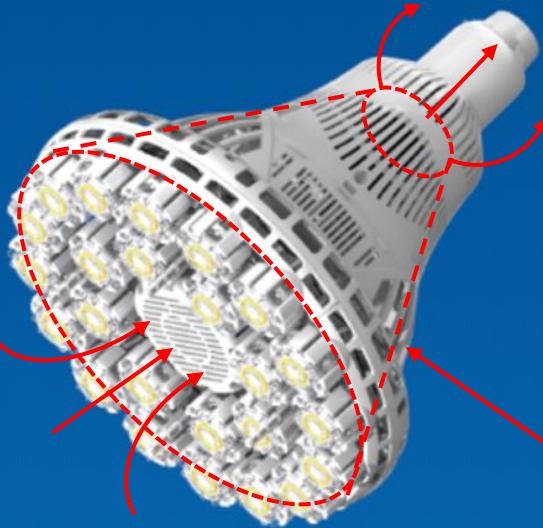
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 1	Analysis	Select Evidence
wherein air passes through the channel to transfer heat from member.	Air passes through the channel of Sansi C21BB-ZE39/E40 High Bay Light to transfer heat from member.	 <p data-bbox="819 612 973 665">air flows into the channel</p> <p data-bbox="1543 360 1719 414">air flows out of the channel</p> <p data-bbox="1564 703 1888 740">concealed channel (inside)</p> <p data-bbox="804 789 1459 816">Source: http://www.sansi.com/products/highbay/305.htm</p>

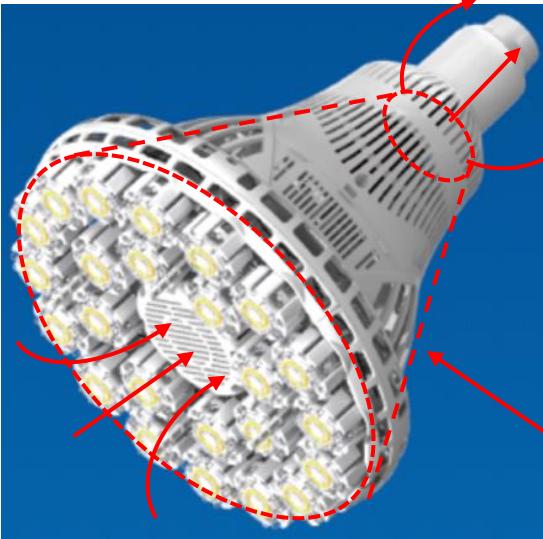
Claim 2	Analysis	Select Evidence
The light fixture of claim 1, wherein the heat is transferred from the member through the channel by convection.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the heat is transferred from the member through the channel by convection.	 <p data-bbox="819 1274 973 1328">air flows into the channel</p> <p data-bbox="1543 1019 1719 1073">air flows out of the channel</p> <p data-bbox="1564 1166 1867 1253">heat transfers from the member through the channel by convection</p> <p data-bbox="1564 1367 1888 1405">concealed channel (inside)</p> <p data-bbox="804 1454 1459 1480">Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

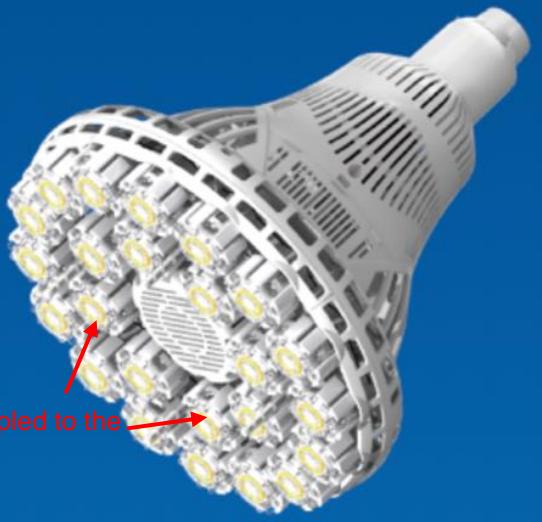
Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 3	Analysis	Select Evidence
<p>The light fixture of claim 1, wherein the channel is configured to transfer the heat from the member by a venturi effect.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the channel is configured to transfer the heat from the member by a venturi effect.</p>	 <p>A photograph of the Sansi C21BB-ZE39/E40 High Bay Light. A dashed red circle highlights a central area containing numerous yellow LEDs. Red arrows indicate air flow: one arrow points into the central area from the bottom left, another points upwards and outwards from the top right, and a third points downwards and outwards from the bottom right. Labels with arrows point to these features: "air flows into the channel" points to the intake arrow; "air flows out of the channel (venturi effect)" points to the top-right exhaust arrow; and "concealed channel (inside)" points to the dashed red circle.</p>

Source: <http://www.sansi.com/products/highbay/305.htm>

Claim 13	Analysis	Select Evidence
<p>The light fixture of claim 1, wherein each light emitting diode is removably coupled to its respective receiving surface via a substrate that is in thermal contact with the receiving surface.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein each light emitting diode is removably coupled to its respective receiving surface via a substrate that is in thermal contact with the receiving surface.</p>	 <p>A photograph of the Sansi C21BB-ZE39/E40 High Bay Light. Two red arrows point to the exterior surface of the light fixture, specifically to the area around the LEDs, with the text "LEDs are removably coupled to the exterior surface" written between them.</p>

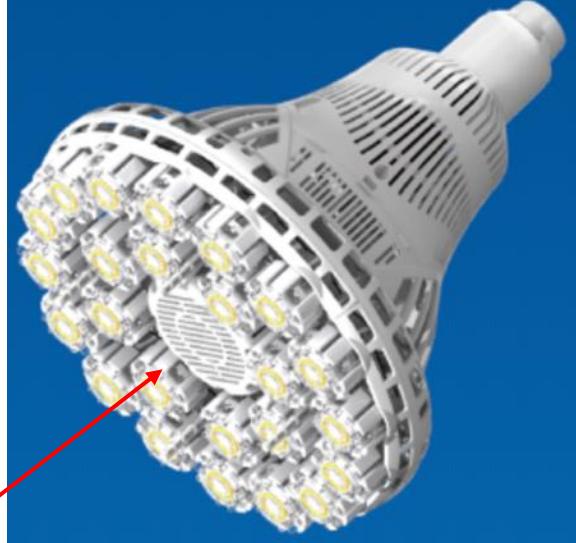
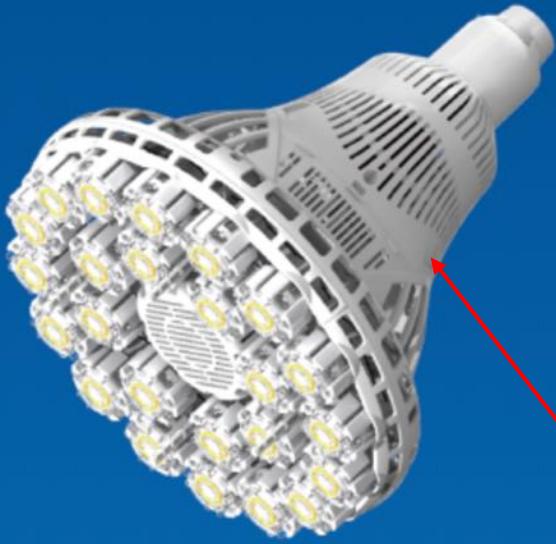
Source: <http://www.sansi.com/products/highbay/305.htm>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



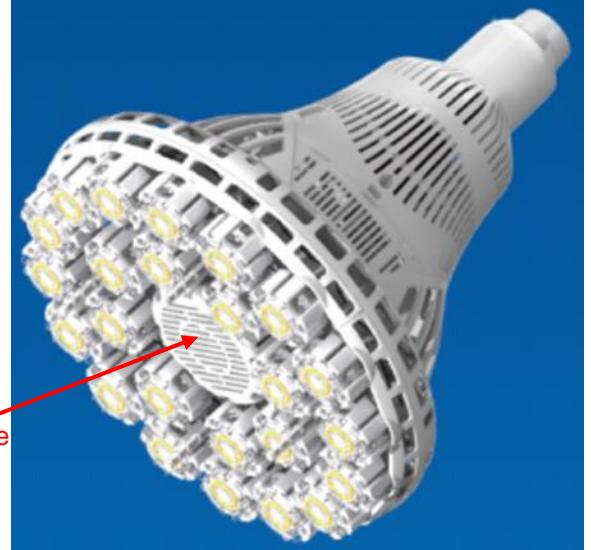
Claim 16	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an interior surface;	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a member comprising an interior surface.	 <p>A photograph of the Sansi C21BB-ZE39/E40 High Bay Light. The image shows the bulb from a side-on perspective, highlighting the array of yellow LED chips on the interior surface. A red arrow points to this array with the label "interior surface (concealed)".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
an exterior surface;	Sansi C21BB-ZE39/E40 High Bay Light has an exterior surface.	 <p>A photograph of the Sansi C21BB-ZE39/E40 High Bay Light. The image shows the bulb from a side-on perspective, highlighting the textured exterior surface. A red arrow points to this surface with the label "exterior surface".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



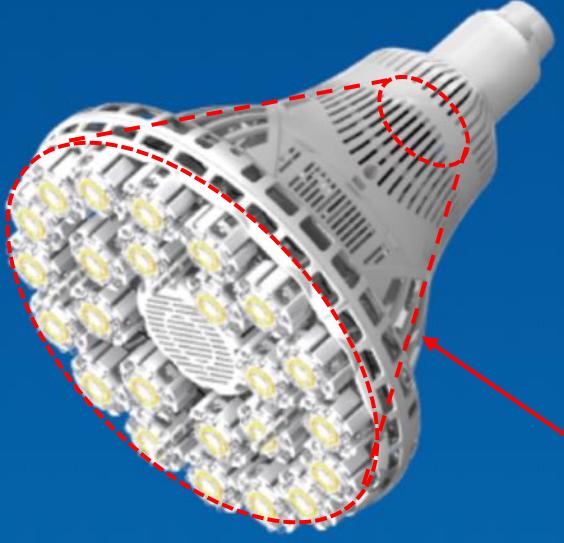
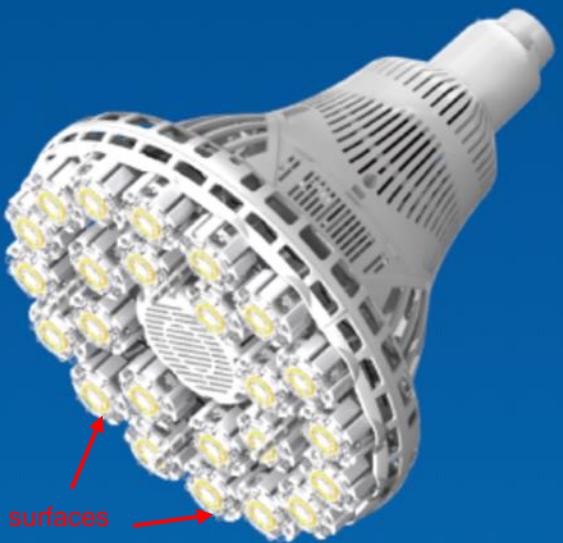
Claim 16	Analysis	Select Evidence
a first aperture disposed along a top end;	Sansi C21BB-ZE39/E40 High Bay Light has a first aperture disposed along a top end.	 <p>A photograph of a white, cylindrical LED high bay light bulb. The bulb has a textured, ribbed top end. A red arrow points to one of the circular apertures on the top surface, labeled "first aperture".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
second aperture disposed along a second end;	Sansi C21BB-ZE39/E40 High Bay Light has a second aperture disposed along a second end.	 <p>A photograph of the same white, cylindrical LED high bay light bulb, shown from a different angle. A red arrow points to one of the circular apertures on the bottom surface, labeled "second aperture".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



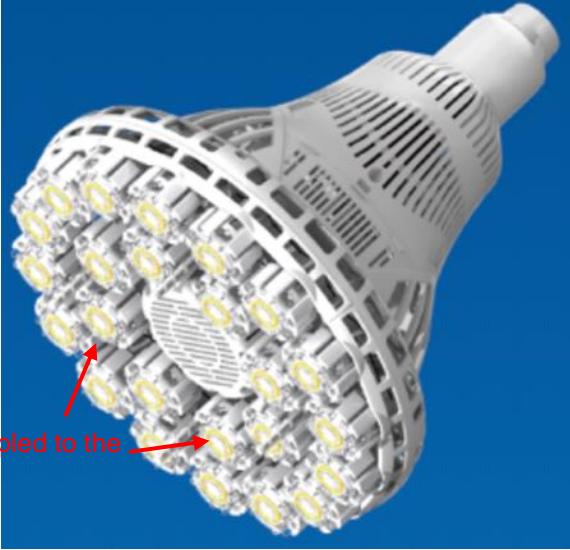
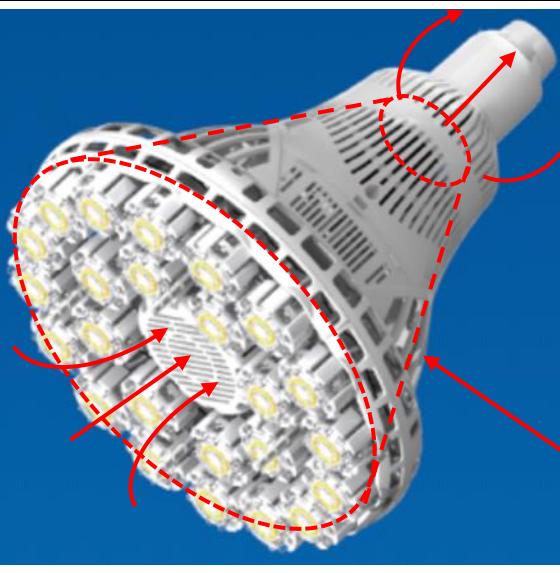
Claim 16	Analysis	Select Evidence
a channel extending from the first aperture to the second aperture and defined by the interior surface; and	Sansi C21BB-ZE39/E40 High Bay Light has a channel extending from the first aperture to the second aperture and defined by the interior surface.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a plurality of receiving surfaces disposed at least partially along the exterior surface, each receiving surface configured to receive at least one light emitting diode; and	Sansi C21BB-ZE39/E40 High Bay Light has a plurality of receiving surfaces disposed at least partially along the exterior surface, each receiving surface configured to receive at least one light emitting diode.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



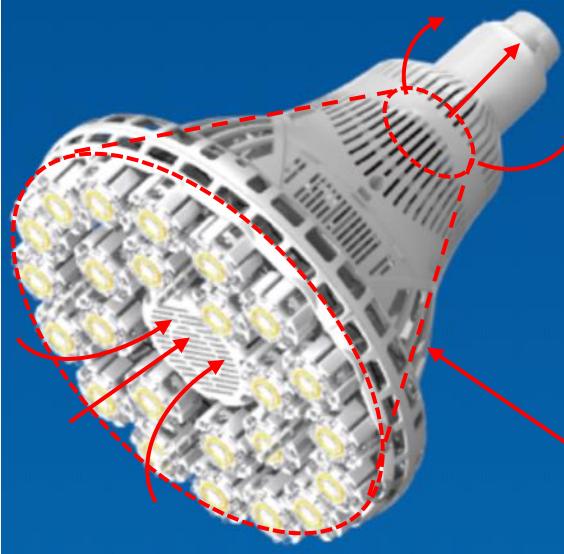
Claim 16	Analysis	Select Evidence
at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces,	Sansi C21BB-ZE39/E40 High Bay Light has at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces.	 <p data-bbox="819 665 1262 719">LEDs are removably coupled to the exterior surface</p> <p data-bbox="808 788 1474 817">Source: http://www.sansi.com/products/highbay/305.htm</p>
wherein the channel transfers at least a portion of heat generated by the light emitting diode through the first aperture.	Sansi C21BB-ZE39/E40 High Bay Light has a channel that transfers at least a portion of heat generated by the light emitting diode through the first aperture.	 <p data-bbox="819 1204 977 1258">air flows into the channel</p> <p data-bbox="1558 959 1738 1013">air flows out of the channel</p> <p data-bbox="1569 1302 1907 1331">concealed channel (inside)</p> <p data-bbox="808 1393 1474 1423">Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

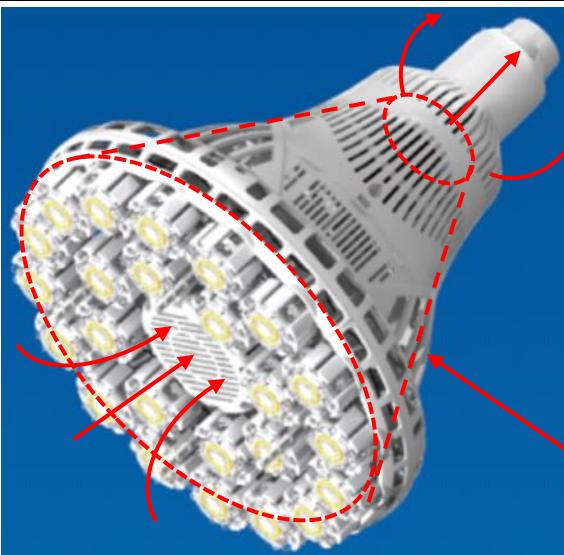
Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 17	Analysis	Select Evidence
The light fixture of claim 16, wherein the heat is transferred from the member through the channel by convection.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the heat is transferred from the member through the channel by convection.	 <p>The image shows a side view of the Sansi C21BB-ZE39/E40 High Bay Light. A dashed red circle highlights the LED array area. Red arrows indicate air flow: one arrow points into the fixture from the bottom left, labeled "air flows into the channel"; another arrow points out from the top right, labeled "air flows out of the channel"; and a third arrow points away from the fixture towards the top right, labeled "heat transfers from the member through the channel by convection". A label "concealed channel (inside)" points to the internal structure of the fixture.</p>

Source: <http://www.sansi.com/products/highbay/305.htm>

Claim 18	Analysis	Select Evidence
The light fixture of claim 16, wherein the heat is transferred from the member through the channel by a venturi effect.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the heat is transferred from the member through the channel by a venturi effect.	 <p>The image shows a side view of the Sansi C21BB-ZE39/E40 High Bay Light. A dashed red circle highlights the LED array area. Red arrows indicate air flow: one arrow points into the fixture from the bottom left, labeled "air flows into the channel"; another arrow points out from the top right, labeled "air flows out of the channel (venturi effect)"; and a third arrow points away from the fixture towards the top right, labeled "heat transfers from the member through the channel by convection". A label "concealed channel (inside)" points to the internal structure of the fixture.</p>

Source: <http://www.sansi.com/products/highbay/305.htm>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



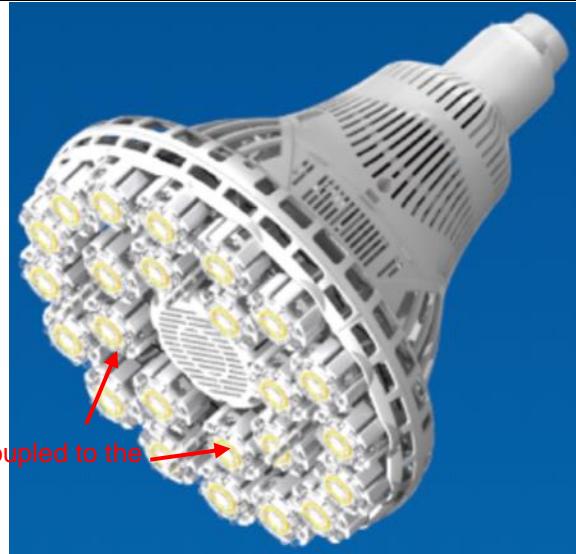
Claim 21	Analysis	Select Evidence
<p>The light fixture of claim 16, wherein each light emitting diode is removably coupled to its corresponding receiving surface via a substrate that is in thermal contact with the receiving surface.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein each light emitting diode is removably coupled to its corresponding receiving surface via a substrate that is in thermal contact with the receiving surface.</p>	 <p data-bbox="819 703 1262 752">LEDs are removably coupled to the exterior surface</p> <p data-bbox="798 850 1480 881">Source: http://www.sansi.com/products/highbay/305.htm</p>

EXHIBIT 12

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



U.S. Patent No. 8,939,608: Sansi C21BB-WE Omni-directional Light Bulb¹

Claim 15	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an interior surface;	Sansi C21BB-WE Omni-directional Light Bulb is a light fixture comprising a member comprising an interior surface.	<div style="text-align: center;">  <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p> </div>

¹ Although this claim chart uses Sansi C21BB-WE Omni-directional Light Bulb as an example, other products in the same family infringe this patent in the same way. Those products include, at least, Sansi C21BB-TE26 UV Light Bulb, Sansi C21BB-QE Smart RGB Light Bulb, Sansi C21BB-TE26/27 Plain Light Bulb, Sansi C21BB-RE Dimmable Light Bulb, and Sansi C21BB-UE Light Bulb.

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



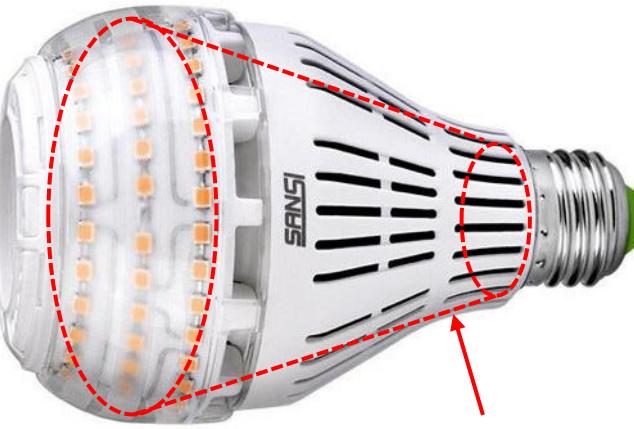
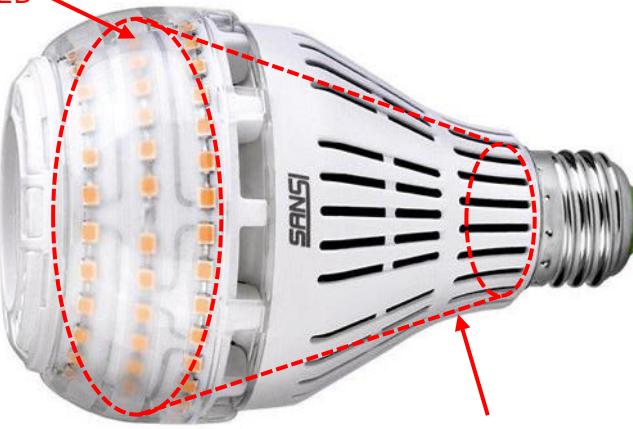
Claim 15	Analysis	Select Evidence
a first aperture;	Sansi C21BB-WE Omni-directional Light Bulb has a first aperture.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
a second distal aperture, and	Sansi C21BB-WE Omni-directional Light Bulb has a second distal aperture.	 <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 15	Analysis	Select Evidence
a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface of the member;	Sansi C21BB-WE Omni-directional Light Bulb has a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface of the member.	 <p>concealed channel (inside)</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>
at least one first light emitting diode (LED) coupled adjacent a first side of the channel; and	Sansi C21BB-WE Omni-directional Light Bulb has at least one first light emitting diode (LED) coupled adjacent a first side of the channel.	 <p>first LED</p> <p>concealed channel (inside)</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 15	Analysis	Select Evidence
<p>at least one second LED coupled adjacent a second side of the channel, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb has at least one second LED coupled adjacent a second side of the channel, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.</p>	<p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Claim 16	Analysis	Select Evidence
<p>The light fixture of claim 15, wherein the second side of the channel is opposite the first side of the channel.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the second side of the channel is opposite the first side of the channel.</p>	<p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 17	Analysis	Select Evidence
<p>The light fixture of claim 15, wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.</p>	 <p>A photograph of a SANSI C21BB-WE LED light bulb. The bulb is white with a black base. A central vertical channel is visible, containing several orange LED components. Red dashed arrows indicate air flow: one arrow points into the top left of the channel, another points out from the top right, and a third points out from the bottom right. Labels with red arrows point to these features: "air flows into the channel", "air flows out of the channel (venturi effect)", and "concealed channel (inside)".</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

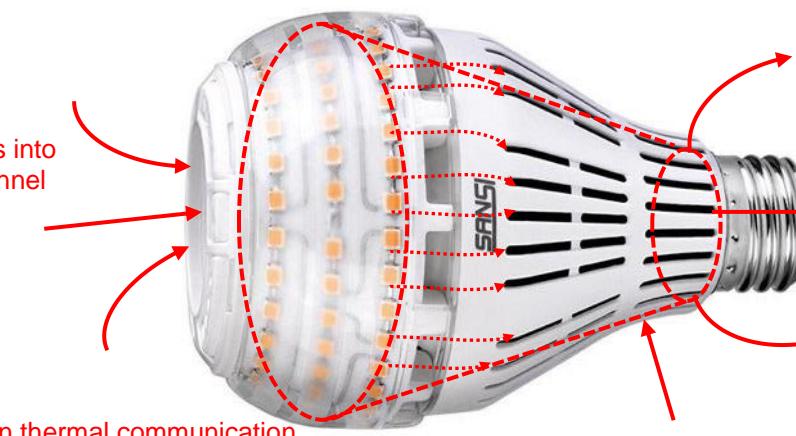
Claim 18	Analysis	Select Evidence
<p>The light fixture of claim 15, wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.</p>	<p>Sansi C21BB-WE Omni-directional Light Bulb is a light fixture wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.</p>	 <p>A photograph of a SANSI C21BB-WE LED light bulb. The bulb is white with a black base. A central vertical channel is visible, containing several orange LED components. Red dashed arrows indicate air flow: one arrow points into the top left of the channel, another points out from the top right, and a third points out from the bottom right. Labels with red arrows point to these features: "air flows into the channel", "air flows out of the channel", and "concealed channel (inside)".</p> <p>LEDs are in thermal communication with the member and configured to transfer heat by convection</p> <p>Source: https://www.homedepot.com/p/SANSI-250-Watt-Equivalent-A21-Dimmable-270-Omni-Directional-LED-Light-Bulb-Soft-Warm-White-in-3000K-2-Pack-01-02-001-022731/312572901</p>

EXHIBIT 13

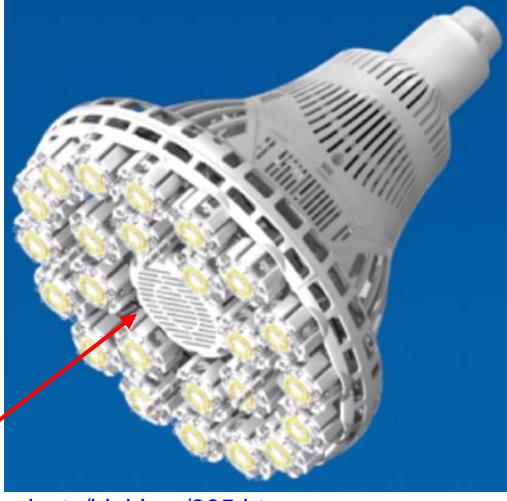
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



U.S. Patent No. 8,939,608: Sansi C21BB-ZE39/E40 High Bay Light¹

Claim 15	Analysis	Select Evidence
A light fixture, comprising: a member comprising: an interior surface;	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture comprising a member comprising an interior surface.	 <p>A photograph of a Sansi C21BB-ZE39/E40 High Bay Light bulb. The bulb has a white plastic housing with a textured pattern. A red arrow points to the bottom of the bulb, specifically to the area where the LED chips are visible through the housing, with the label "interior surface (concealed)".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a first aperture;	Sansi C21BB-ZE39/E40 High Bay Light has a first aperture.	 <p>A photograph of the same Sansi C21BB-ZE39/E40 High Bay Light bulb from a slightly different angle. A red arrow points to the bottom edge of the bulb, highlighting the circular opening which is labeled "first aperture".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

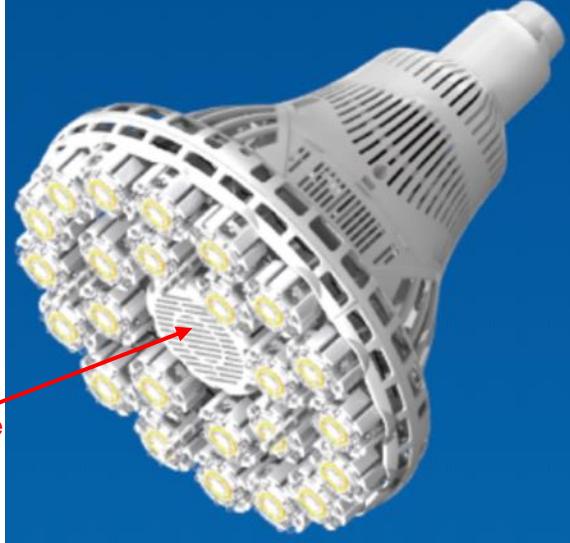
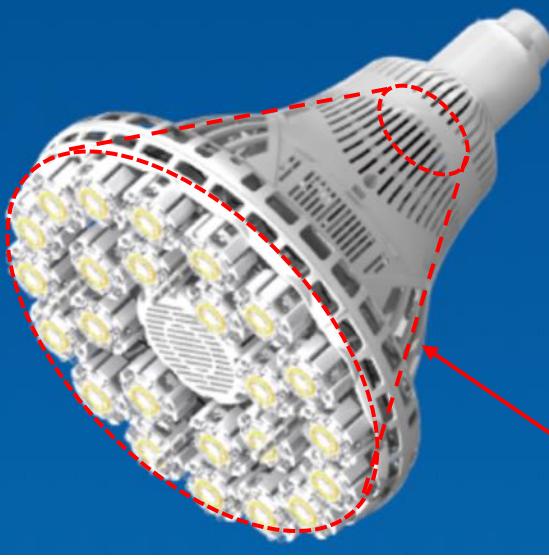
¹ Although this claim chart uses Sansi C21BB-ZE39/E40 High Bay Light as an example, other products in the same family infringe this patent in the same way. Those products include, at least, Sansi C21GL-CE26/27 Full Spectrum Glow Light and BR30 Non-Dimmable LED Light Bulb.

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



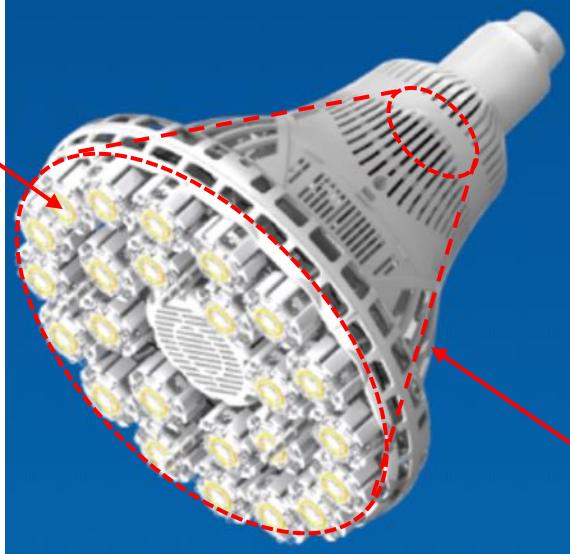
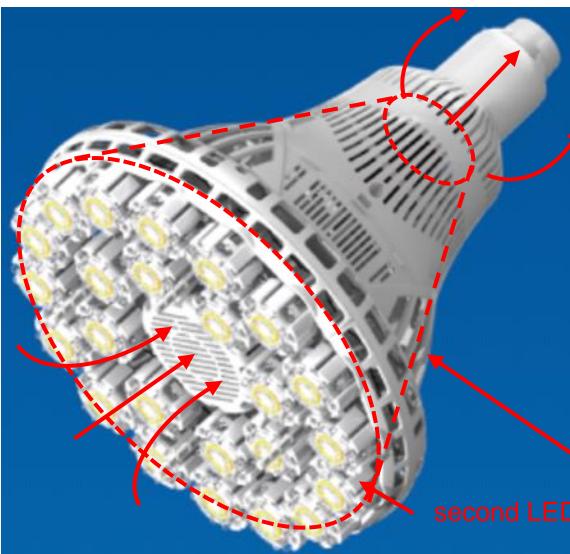
Claim 15	Analysis	Select Evidence
a second distal aperture, and	Sansi C21BB-ZE39/E40 High Bay Light has a second distal aperture.	 <p>A photograph of a white, cylindrical LED light bulb. A red arrow points to a small circular opening on the side of the bulb, labeled "second aperture".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>
a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface of the member;	Sansi C21BB-ZE39/E40 High Bay Light has a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface of the member.	 <p>A photograph of the same light bulb, but with a large red dashed circle highlighting a specific area on the side. A red arrow points to the interior of this circle, labeled "concealed channel (inside)".</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



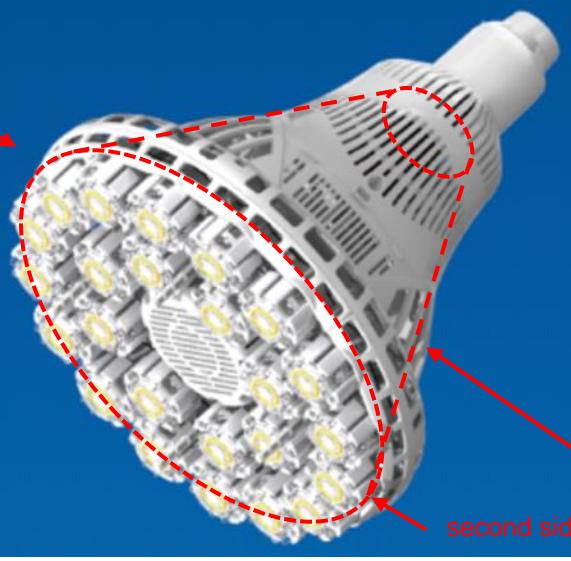
Claim 15	Analysis	Select Evidence
at least one first light emitting diode (LED) coupled adjacent a first side of the channel; and	Sansi C21BB-ZE39/E40 High Bay Light has at least one first light emitting diode (LED) coupled adjacent a first side of the channel.	 <p data-bbox="819 355 925 376">first LED</p> <p data-bbox="1558 703 1881 724">concealed channel (inside)</p> <p data-bbox="804 806 1465 833">Source: http://www.sansi.com/products/highbay/305.htm</p>
at least one second LED coupled adjacent a second side of the channel, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	Sansi C21BB-ZE39/E40 High Bay Light has at least one second LED coupled adjacent a second side of the channel, wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	 <p data-bbox="819 1220 973 1274">air flows into the channel</p> <p data-bbox="1543 980 1733 1034">air flows out of the channel</p> <p data-bbox="1410 1334 1537 1356">second LED</p> <p data-bbox="1543 1323 1902 1344">concealed channel (inside)</p> <p data-bbox="804 1416 1465 1444">Source: http://www.sansi.com/products/highbay/305.htm</p>

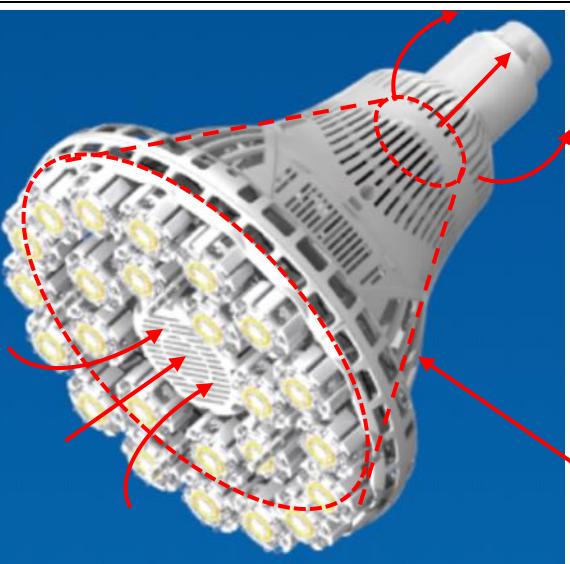
Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



Claim 16	Analysis	Select Evidence
The light fixture of claim 15, wherein the second side of the channel is opposite the first side of the channel.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the second side of the channel is opposite the first side of the channel.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Claim 17	Analysis	Select Evidence
The light fixture of claim 15, wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.	Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the channel is configured to transfer at least the portion of the heat generated by the first and second LEDs by venturi effect.	 <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

Disclosure Pursuant to FRE 408

Non-limiting example of infringement based on information presently available (draft/subject to revision)

Claim preamble may not serve as a limitation.



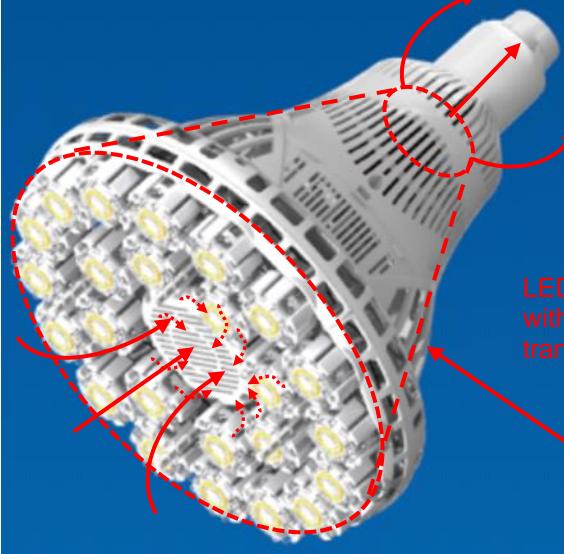
Claim 18	Analysis	Select Evidence
<p>The light fixture of claim 15, wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.</p>	<p>Sansi C21BB-ZE39/E40 High Bay Light is a light fixture wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.</p>	 <p>A photograph of a Sansi C21BB-ZE39/E40 High Bay Light bulb. The bulb has a cylindrical shape with a textured base. Red dashed lines form a circular path around the middle of the bulb, indicating a 'concealed channel (inside)'. Arrows show air flowing from the bottom left into the channel and from the top right out of the channel. The LED array is visible at the base, with text pointing to it stating 'LEDs are in thermal communication with the member and configured to transfer heat by convection'.</p> <p>Source: http://www.sansi.com/products/highbay/305.htm</p>

EXHIBIT 14

Confidential/Attorney Work Product

August 27, 2020

VIA EMAIL (rolson@giplg.com)

Global IP Law Group, LLC
 Attn: Ragnar Olson
 55 W Monroe Street, Suite 3400
 Chicago, IL 60603
 Phone: 312-241-1500;

Re: Lighting Defense Group, LLC Patents 8,256,923; 8,939,608; 7,874,700; and 9,163,807.

Dear Mr. Olson:

I am an outside counsel retained by Shanghai Sansi Electronic Engineering Co., Ltd. ("Sansi"). On June 26, 2020, Sansi received a communication from you notifying your representation of Lighting Defense Group ("LDG") regarding to US patents 8,256,923 ("the '923 patent"); 8,939,608 ("the '608 patent"); 7,874,700 ("the '700 patent"); and 9,163,807 ("the '807 patent"), collectively the "LDG Patents". The communication included a letter from you, multiple claim charts, and analysis of certain Sansi products with respect to the above LDG Patents.

After reviewing the LDG Patents and the above materials provided by you, it is our position that at this moment, Sansi does NOT need to obtain a license to the LDG Patents, at least for the following reasons:

First of all, Sansi's products most likely do NOT infringe the following independent claims (and their respective dependent claims) of the LDG Patents. Specifically, we believe Sansi's products do NOT include or perform all limitations of the following independent claims, as shown in the attached Claim Analysis Section A.

- '923 Patent: Claims 1, 12 and 17
- '608 Patent: Claim 15
- '700 Patent: Claims 1 and 16
- '807 Patent: Claim 14

Secondly, the following independent and dependent claims of the LDG Patents may either be vague or indefinite, and/or be anticipated by prior arts. In other words, we believe the following claims have a very high probability of being invalidated in an IPR challenge, as shown in the attached Claim Analysis Section B.

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- '923 Patent: Claims 1, 3, 4, 12, 14, 15, 17, 18, 19, 20
- '608 Patent: Claims 15, 16, 18
- '807 Patent: Claims 14, 17

Furthermore, many of the Sansi's products may be discontinued or redesigned, which may render some of the alleged claim infringement analysis moot.

In conclusion, we have high confidence that Sansi's products currently being sold in the US market either do NOT infringe any of the LDG Patents' claims as listed in the documents you provided, or many of claims in the LDG Patents are NOT enforceable against Sansi's products. In this case, a license of the LDG Patents is highly unnecessary.

If you have any questions, or would like to have further discussion, please do not hesitate to contact us.

Best regards,

/Xiaofei Xue/

XUE, Xiaofei
US Patent Attorney
JZMC Patent and Trademark Law Office
Email: xxf@iprtop.com
Phone: (86)-21-51096606

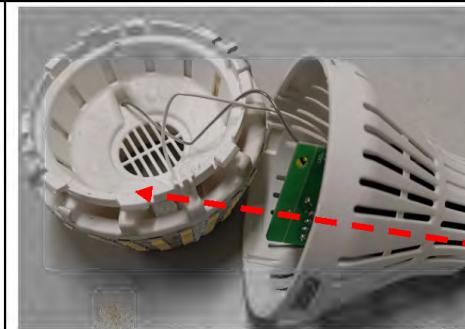
Claim Analysis Section A

US 8,256,923

	[Claim 1] A light fixture, comprising: a member comprising:	Notes
1.1	a top end comprising a first aperture;	
1.2	a bottom end comprising a second aperture,	
1.3	a channel extending from the first aperture to the second aperture and defined by an interior surface of the member;	
1.4	a plurality of light emitting diodes (LEDs) disposed on the fixture adjacent to the channel, wherein at least one LED is located on one side of the channel and at least another LED is located on an opposite side of the channel;	
1.5	wherein air enters the channel through the second aperture and exits the channel through the first aperture; and	
1.6	wherein the LEDs transfer heat through the member to the air in the channel.	<p>In the following Sansi's product:</p>  <p>Heat generated by the LEDs are dissipated through the surrounding air into the environment. The LEDs do NOT transfer heat through any member to the air in the channel.</p>



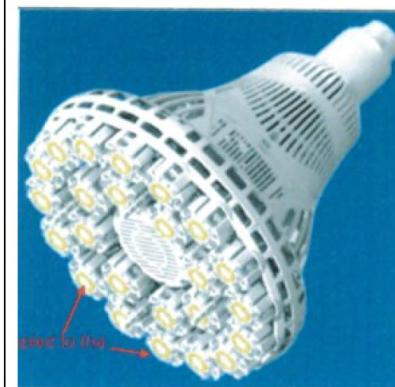
Confidential/Attorney Work Product



Heat Isolation Panel

Heat generated by the LEDs are further blocked by the Heat Isolation Panel located between the LEDs and the member. The Heat Isolation Panel prevents the transferring of heat from the LEDs to the interior of the light bulb.

In the following Sansi's product:



Heat generated by the LEDs are dissipated through the surrounding air into the environment. The LEDs do NOT transfer heat through any member to the air in the channel.

To summarize, the above alleged Sansi's products do not include LEDs that transfer heat through the member to the air in the channel.

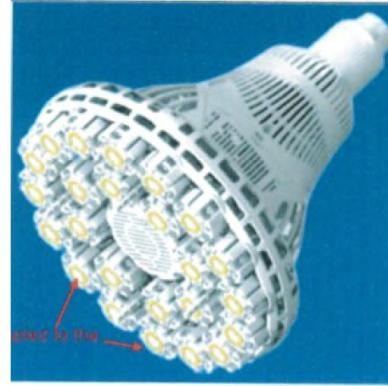


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	[Claim 12] A light fixture, comprising: a member comprising:	Notes
12.1	an interior surface;	
12.2	an exterior surface;	
12.3	a first aperture disposed along a first end;	
12.4	a second aperture disposed along a distal second end;	
12.5	a channel extending from the first aperture to the second aperture and defined by the interior surface; and	
12.6	a plurality of light emitting diodes (LEDs) positioned adjacent to the channel; wherein a first of the plurality of LEDs is disposed adjacent a first portion of the channel and a second of the plurality of LEDs is disposed adjacent a second portion of the channel different than the first portion; and	
12.7	wherein air passes through the channel from the second aperture to the first aperture and transfers at least a portion of heat generated by the first LED and the second LED through the first aperture.	<p>In the following Sansi's product:</p>  <p>Heat generated by the LEDs are dissipated through the surrounding air into the environment. Air entering into the interior of the light bulb is for transferring heat generated by the control circuitry located inside of the light bulb.</p>



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	<p>In the following Sansi's product:</p>  <p>Heat generated by the LEDs are dissipated through the surrounding air into the environment. Air entering into the interior of the light bulb is for transferring heat generated by the control circuitry located inside of the light bulb.</p> <p>To summarize, the above alleged Sansi's products do not cause the transferring of at least a portion of the heat generated by the first and second LEDs through the first aperture.</p>
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	[Claim 17] A light fixture, comprising: a member comprising:	Notes
17.1	an interior surface	
17.2	a first aperture;	
17.3	a second distal aperture,	
17.4	a channel through the member extending from the first aperture to the second aperture and defined by the interior surface of the member;	



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17.5	at least one first light emitting diode (LED) coupled adjacent a first side of the channel;	
17.6	at least one second LED coupled adjacent a second side of the channel;	
17.7	wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	<p>Same as analyzed in 12.7 above.</p> <p>To summarize, the above alleged Sansi's products do not cause the transferring of at least a portion of the heat generated by the first and second LEDs through the first aperture.</p>

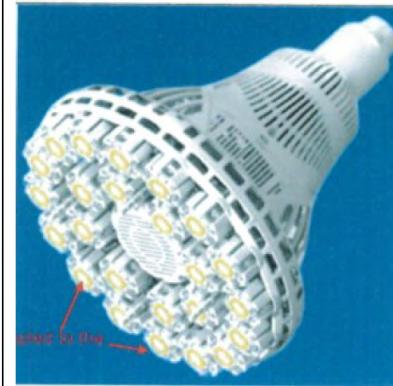
US 9,163,807

	[Claim 14] A light fixture, comprising: a member comprising:	Notes
14.1	an interior surface;	
14.2	an exterior surface;	
14.3	a first aperture disposed along a top end of the member;	
14.4	a second aperture disposed along a bottom end of the member, and a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface;	
14.5	at least one first light emitting diode (LED) coupled to a first facet of the exterior surface; and	
14.6	at least one second LED coupled to a second facet of the exterior surface,	
14.7	wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	In the following Sansi's product:  Heat generated by the LEDs are dissipated through the surrounding air into the environment. Air entering into the interior of the light bulb is for transferring heat generated by the control circuitry located inside of the light bulb.



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In the following Sansi's product:



Heat generated by the LEDs are dissipated through the surrounding air into the environment. Air entering into the interior of the light bulb is for transferring heat generated by the control circuitry located inside of the light bulb.

To summarize, the above alleged Sansi's products do not cause the transferring of at least a portion of the heat generated by the first and second LEDs through the first aperture.

US 7,874,700

	[Claim 1]	Notes
	A light fixture, comprising: a member comprising:	
1.1	a first surface disposed along an interior of the member;	
1.2	a second surface disposed along an exterior of the member;	
1.3	a first end comprising a first aperture;	
1.4	a second end comprising a second aperture;	
1.5	a channel extending from the first aperture to the second aperture and defined by the first surface; and	
1.6	a plurality of receiving surfaces disposed at least partially around the channel, along the second surface of the member, each receiving surface being configured to receive at least one light emitting diode; and	
1.7	at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces,	<p>“Removably” indicates that a LED coupled to a “receiving surface” can be subsequently removed from the “receiving surface” without significantly affecting the functioning of the light fixture.</p> <p>In the following Sansi's product:</p>  <p>None of the LEDs can be removed from their respective positions. Any removal of the LEDs will render the light bulb useless.</p>



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		<p>In the following Sansi's product:</p>  <p>None of the LEDs can be removed from their respective positions. Any removal of the LEDs will render the light bulb useless.</p> <p>To summarize, the above alleged Sansi's products do not include LEDs being removably coupled to receiving surfaces.</p>
1.8	wherein the light emitting diodes transfer heat through conduction to the member; and wherein air passes through the channel to transfer heat from member.	

	[Claim 16]	Notes
	A light fixture, comprising: a member comprising:	
16.1	an interior surface;	
16.2	an exterior surface;	
16.3	a first aperture disposed along a top end;	
16.4	second aperture disposed along a second end;	
16.5	a channel extending from the first aperture to the second aperture and defined by the interior surface; and	



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16.6	a plurality of receiving surfaces disposed at least partially along the exterior surface, each receiving surface configured to receive at least one light emitting diode; and	
16.7	at least one light emitting diode, each light emitting diode being removably coupled to a respective one of the receiving surfaces,	<p>Same as analyzed in 1.7 above.</p> <p>To summarize, the alleged Sansi's products do not include LEDs being removably coupled to receiving surfaces.</p>
16.8	wherein the channel transfers at least a portion of heat generated by the light emitting diode through the first aperture.	



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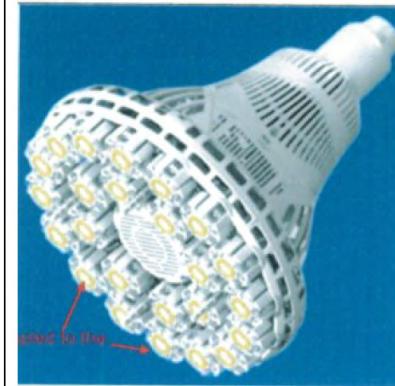
US 8,939,608

	[Claim 15] A light fixture, comprising: a first member comprising:	Notes
15.1	an interior surface;	
15.2	a first aperture;	
15.3	a second distal aperture, and	
15.4	a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface of the member;	
15.5	at least one first light emitting diode (LED) coupled adjacent a first side of the channel; and	
15.6	at least one second LED coupled adjacent a second side of the channel,	
15.7	wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	In the following Sansi's product:  Heat generated by the LEDs are dissipated through the surrounding air into the environment. Air entering into the interior of the light bulb is for transferring heat generated by the control circuitry located inside of the light bulb.



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In the following Sansi's product:

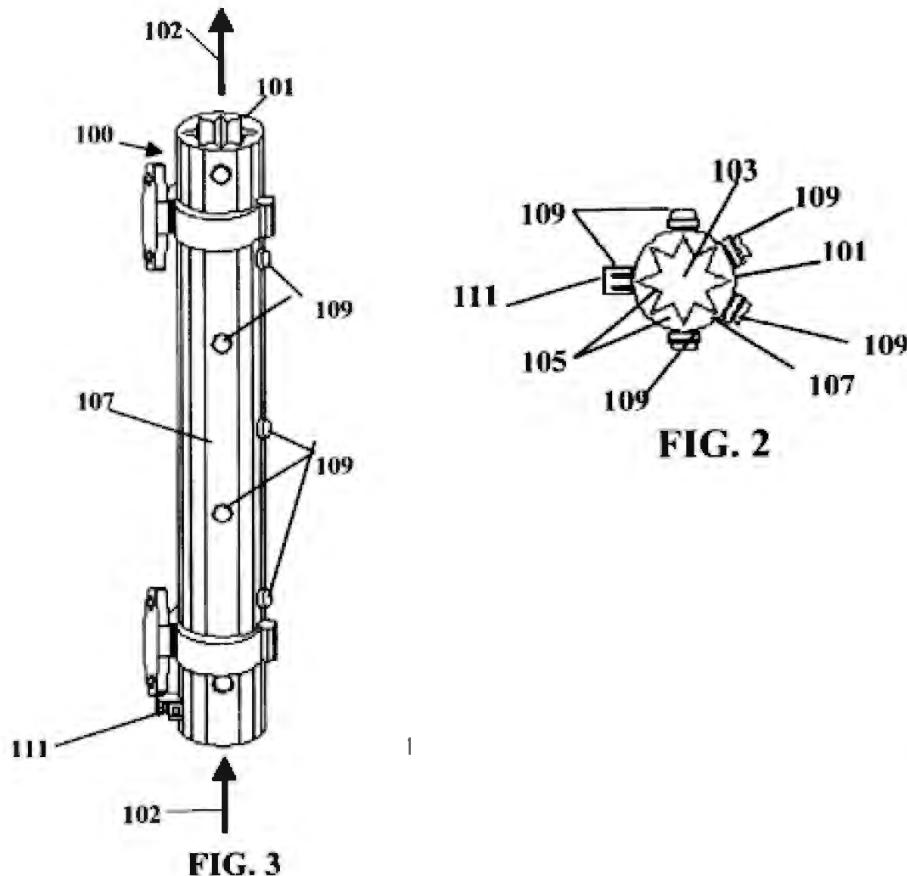


Heat generated by the LEDs are dissipated through the surrounding air into the environment. Air entering into the interior of the light bulb is for transferring heat generated by the control circuitry located inside of the light bulb.

To summarize, the above alleged Sansi's products do not cause the transferring of at least a portion of the heat generated by the first and second LEDs through the first aperture.

Claim Analysis Section B

LDG Patents in view of Prior Art US 6,831,303 (“Dry”) with a Priority Date May 29, 2002

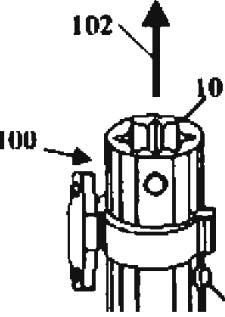
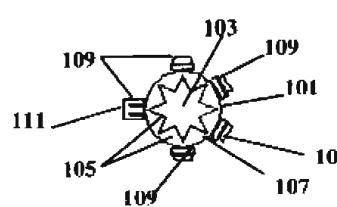


A light source 100
An elongate thermally heat sink 101
An interior cavity 103
A plurality of Light Emitting Diodes 109
The exterior surface 107
Heat dissipating fins 105



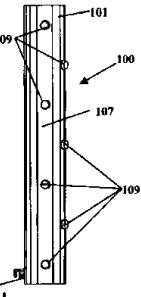
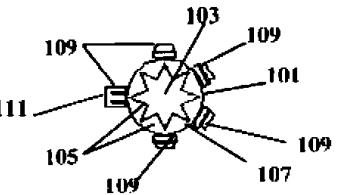
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US 8,256,923 in view of Dry

	[Claim 1] A light fixture, comprising: a member comprising:	Anticipated by Dry
1.1	a top end comprising a first aperture;	 <p>Dry's tubular heat sink 101 has a top end.</p>
1.2	a bottom end comprising a second aperture,	 <p>FIG. 2 Dry's sink 101 has a bottom end.</p>



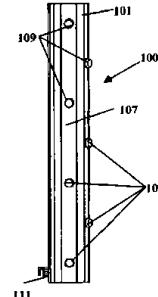
Confidential/Attorney Work Product

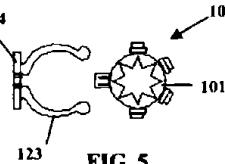
1.3	a channel extending from the first aperture to the second aperture and defined by an interior surface of the member;	 <p>Dry's sink 101 has a channel extending from the lower end to the upper end and defined by an interior surface of the cavity 103. See Dry col. 4, line 1.</p>
1.4	a plurality of light emitting diodes (LEDs) disposed on the fixture adjacent to the channel, wherein at least one LED is located on one side of the channel and at least another LED is located on an opposite side of the channel;	 <p>FIG. 2 The exterior surface 107 of the elongate heat sink 101 has a plurality of Light Emitting Diodes 109 disposed thereon, wherein at least one LED 109 is located on one side of the heat sink 101 and at least another LED 109 is located on an opposite side of the heat sink 101. See Dry Fig. 2.</p>
1.5	wherein air enters the channel through the second aperture and exits the channel through the first aperture; and	<p>Cool or unheated air enters tubular heat sink 101 at its lower end and exits from the upper end as heated air. See Dry Col. 4, line 1.</p> <p style="color: red;">Further, this claim element is reciting a natural phenomenon.</p>



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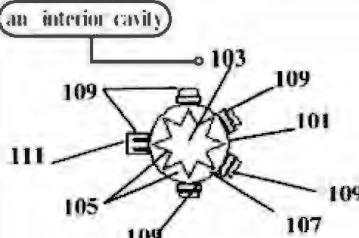
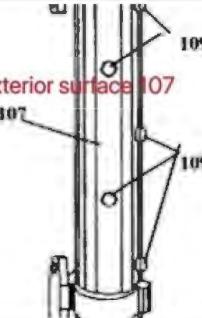
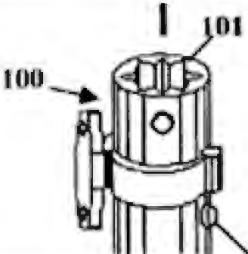
1.6	wherein the LEDs transfer heat through the member to the air in the channel.	Flexible printed circuit 113 is adhered to the heat sink 101 with a heat conducting epoxy to aid in the transmission of the heat from LEDs 109 to the tube 101. See Dry col. 3, line 40-42.
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	[Claim 3] The light fixture of claim 1, further comprising	Anticipated by Dry
3.1	a plurality of LED receiving surfaces, wherein the LED receiving surfaces are disposed at least partially around the channel.	 <p>LEDs 109 are disposed at least partially around the sink 101. Also see Dry claim 21.</p>

	[Claim 4] The light fixture of claim 1, further comprising	Anticipated by Dry
4.1	a mounting member extending outwardly in a direction substantially orthogonal to a longitudinal axis of the channel.	 <p>FIG. 5 Mounting clip 123 and 124.</p>

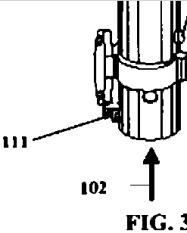


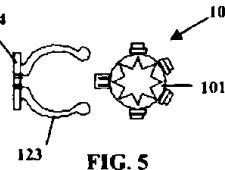
Confidential/Attorney Work Product

	[Claim 12] A light fixture, comprising: a member comprising:	Anticipated by Dry
12.1	an interior surface;	 <p>FIG. 2</p> <p>Interior surface defined by cavity 103.</p>
12.2	an exterior surface;	 <p>Exterior surface 107.</p>
12.3	a first aperture disposed along a first end;	



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12.4	a second aperture disposed along a distal second end;	 FIG. 3
12.5	a channel extending from the first aperture to the second aperture and defined by the interior surface; and	A channel extending from the first end to the second end and defined by the interior cavity 103;
12.6	a plurality of light emitting diodes (LEDs) positioned adjacent to the channel; wherein a first of the plurality of LEDs is disposed adjacent a first portion of the channel and a second of the plurality of LEDs is disposed adjacent a second portion of the channel different than the first portion; and	A plurality of light emitting diodes 109 carried on said elongate member outer surface, at least some of said light emitting diodes being disposed in a first plane and others of said light emitting diodes being disposed in a second plane not coextensive with said first plane. See Dry claim 21.
12.7	wherein air passes through the channel from the second aperture to the first aperture and transfers at least a portion of heat generated by the first LED and the second LED through the first aperture.	Convection cooling by flow of air through tubular heat sink 101 is utilized such that cool or unheated air enters tubular heat sink 101 at its lower end and exits from the upper end as heated air. See Dry col. 4, line 1.

	[Claim 14] The light fixture of claim 12, further comprising	Anticipated by Dry
14.1	a mounting member extending outwardly from the member in a direction away from a longitudinal axis of the channel.	 FIG. 5 Mounting clip 123 and 124.



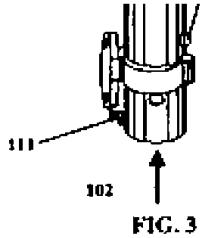
Confidential/Attorney Work Product

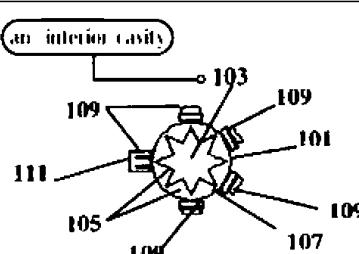
	[Claim 15] The light fixture of claim 12,	Anticipated by Dry
15.1	wherein the heat is transferred from the member through the channel with the air by convection.	Convection cooling by flow of air. See Dry col. 3, lines 65-66.

	[Claim 17] A light fixture, comprising: a member comprising:	Anticipated by Dry
17.1	an interior surface	<p style="text-align: center;">FIG. 2</p>
17.2	a first aperture;	



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17.3	a second distal aperture,	 FIG. 3
17.4	a channel through the member extending from the first aperture to the second aperture and defined by the interior surface of the member;	See 12.5 above.
17.5	at least one first light emitting diode (LED) coupled adjacent a first side of the channel;	At least some of the light emitting diodes are disposed in a first plane. See Dry claim 21.
17.6	at least one second LED coupled adjacent a second side of the channel;	Others of said light emitting diodes are disposed in a second plane not coextensive with the first plane. See Dry claim 21.
17.7	wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	See 12.7 above.

	[Claim 18] The light fixture of claim 17,	Anticipated by Dry
18.1	wherein the second side of the channel is opposite the first side of the channel.	 FIG. 2



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	[Claim 20] The light fixture of claim 17,	Anticipated by Dry
20.1	wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.	said elongate thermally conductive member is configured to conduct heat away from said light emitting diodes to fluid proximate said elongate member outer surface. See Dry claim 21.

US 9,163,807 in view of Dry

	[Claim 14] A light fixture, comprising: a member comprising: an interior surface;	Anticipated by Dry
14.1		<p style="text-align: center;">FIG. 2</p>



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14.2	an exterior surface;	
14.3	a first aperture disposed along a top end of the member;	 FIG. 2
14.4	a second aperture disposed along a bottom end of the member, and a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface;	A channel extending from the first end to the second end and defined by the interior cavity 103.
14.5	at least one first light emitting diode (LED) coupled to a first facet of the exterior surface; and	At least some of the light emitting diodes are disposed in a first plane.
14.6	at least one second LED coupled to a second facet of the exterior surface,	Others of said light emitting diodes are disposed in a second plane not coextensive with the first plane.
14.7	wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	Convection cooling by flow of air through tubular heat sink 101 is utilized such that cool or unheated air enters tubular heat sink 101 at its lower end and exits from the upper end as heated air.



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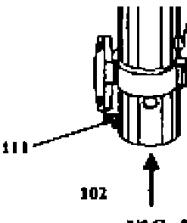
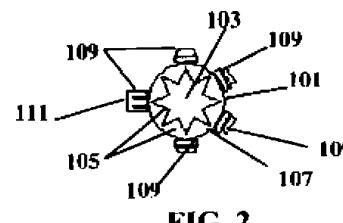
	[Claim 17] The light fixture of claim 14,	Anticipated by Dry
17.1	wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member.	The elongate thermally conductive member conducts heat away from the light emitting diodes. See Dry claim 1.

US 8,939,608 in view of Dry

	[Claim 15] A light fixture, comprising: a first member comprising: 15.1 an interior surface;	<p style="text-align: center;">FIG. 2</p>
15.2	a first aperture;	



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15.3	a second distal aperture, and	 FIG. 3	 FIG. 2
15.4	a channel within the member extending from the first aperture to at least the second aperture and defined by the interior surface of the member;	A channel extending from the first end to the second end and defined by the interior cavity 103.	
15.5	at least one first light emitting diode (LED) coupled adjacent a first side of the channel; and	At least some of the light emitting diodes are disposed in a first plane.	
15.6	at least one second LED coupled adjacent a second side of the channel,	Others of said light emitting diodes are disposed in a second plane not coextensive with the first plane.	
15.7	wherein air enters the channel and transfers at least a portion of the heat generated by the first and second LEDs through the first aperture.	Convection cooling by flow of air through tubular heat sink 101 is utilized such that cool or unheated air enters tubular heat sink 101 at its lower end and exits from the upper end as heated air.	

	[Claim 16] The light fixture of claim 15,	Anticipated by Dry
16.1	wherein the second side of the channel is opposite the first side of the channel.	See Dry Fig. 2.

	[Claim 18] The light fixture of claim 15,	Anticipated by Dry
18.1	wherein the first and second LEDs are in thermal communication with the member and configured to transfer heat to the member by convection.	The elongate thermally conductive member conducts heat away from the light emitting diodes.

EXHIBIT 15

From: wangxiahui@sansitech.com <wangxiahui@sansitech.com>
Sent: Thursday, June 10, 2021 12:46 AM
To: Andrew Ramer <aramer@lightingdefense.com>
Cc: seller-performance <seller-performance@amazon.com>
Subject: contact letter(amazon case ID : 8411289241)

On June 9th, 2021, you complained on the Amazon platform (hereinafter "our") 17W/22W/27W led bulb model product for infringement of the patent: US8939608, but according to our comparative analysis, our 17W/22W/27W led bulb model product did not violate the patent of US8939608. Now that your complaint has affected our daily operation on the Amazon platform, please contact Amazon immediately after receiving this email to withdraw your complaint against us. If you have a different understanding of our non-infringement judgment, we will communicate with you again after you withdraw our complaint. Thank you!

王晓辉
TEL:+86 54883434-1882
E-MAIL : wangxiahui@sansitech.com

上海三思电子工程有限公司
地址 : 上海市闵行区疏影路1280号
Address : No.1280, Shuying Rd, Minhang District, Shanghai, China
www.sansitech.com
www.sansilighting.com

EXHIBIT 16

From: Ma, Yufeng (Ethan) <yma@orrick.com>
Sent: Wednesday, June 23, 2021 11:26 PM
To: Andrew Ramer <aramer@lightingdefense.com>
Cc: Martinelli, Richard F. <rmartinelli@orrick.com>; Shen, Sophia <sshen@orrick.com>; Ning, Weimin <wning@orrick.com>; Brewer, Evan <ebrewer@orrick.com>
Subject: Your Amazon Complaint against Sansi (Amazon Case ID: 8411289241)

Dear Mr. Ramer,

I am writing on behalf of our client Shanghai Sansi Electronic Engineering Co., Ltd. ("Sansi") in relation to the complaint you filed with Amazon against our client. For us to evaluate your claim, please send us a copy of the complaint you submitted to Amazon.

Thank you.

Ethan

Yufeng (Ethan) Ma

Partner

Orrick, Herrington & Sutcliffe
Shanghai

EXHIBIT 17

SANSI LED LIGHTING INC. (4048861)	
	
Request Certificate	
<i>Initial Filing Date</i>	07/27/2017
<i>Status</i>	Active
<i>Standing - SOS</i>	Good
<i>Standing - FTB</i>	Good
<i>Standing - Agent</i>	Good
<i>Standing - VCFCF</i>	Good
<i>Formed In</i>	CALIFORNIA
<i>Entity Type</i>	Stock Corporation - CA - General
<i>Principal Address</i>	30075 AHERN AVE UNION CITY, CA 94587
<i>Mailing Address</i>	30075 AHERN AVE UNION CITY, CA 94587
<i>Statement of Info Due Date</i>	07/31/2023
<i>Agent</i>	Individual 1269253 TINA CHIANG 17870 CASTLETON ST. SUITE 116 CITY OF INDUSTRY, CA 91748

EXHIBIT 18

A Global Leader in LED Displays and Lighting

Kingsun has established itself as a leader in LED displays and lighting. With over 30 years of experience, we offer a wide range of products, services, and solutions to meet your needs. Our mission is to provide innovative and reliable products that enhance your environment.

Key Figures:

- 29+ Years in Industry
- 500+ Global Partners
- 2500+ Professional Staff
- 2300000 m² Manufacturing Capacity

Advanced R&D Capability

Our R&D team is constantly working on new technologies and innovations. We have invested heavily in research and development, including optical, mechanical, software, and hardware development. Our focus is on creating products that are reliable, efficient, and easy to use.

Manufacture Capability

We have three manufacturing facilities located in Shenzhen, China. Our total manufacturing capacity is over 200,000 square meters. We have invested in state-of-the-art machinery and equipment to ensure high-quality production. Our facilities are ISO9001 certified and follow strict quality control procedures.

Development History

1993: Founded
2021: Acquired by Shenzhen Kingsun Technology Co., Ltd.

Innovative Sustainable Committed

Corporate Culture

At Shenzhen Kingsun Technology Co., Ltd., we believe in innovation, sustainability, and commitment. We are committed to providing our customers with the best products and services. We are also committed to protecting the environment and reducing our impact on it. We believe in working together to create a better future for everyone.

Brand Strength

ISO9001 Certified Quality Management System
ISO14001 Certified Environmental Management System
CE Certified Product Safety

Sales Coverage region

Global sales network covering over 100 countries and regions. Our products are used in various industries, including transportation, energy, infrastructure, and more.

Product Categories

Product	Market
LED Displays	Transportation
LED Lighting	Energy
Integrated Intelligent System	Infrastructure
Integrated Intelligent System	Transportation

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